s The OIL WEEKLY

WORLD OIL

SPECIALIZED FOR DRILLING, PRODUCING, PIPE LINE OPERATIONS AND MANAGEMENT

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NEW BJ WELDLESS LINK

with Short Upper Eye . . . Full Diameter Shank

AGAIN BJ LEADS the field with a new designed Weldless Link of forged alloy steel, heat treated. These links have a short upper eye and have been designed for the greatest strength possible. They have full diameter shanks for Link Rated Capacity. The 2¾" links have 3½" plus shank diameter. The 2¼" links have 2⅞" plus shank diameter. **THERE ARE IMITATIONS** of old design BJ Links, but all are shy at the shank diameter or other important sections. This new BJ design was thoroughly tested in the field and was API Rated before any sales were accepted. These Short-Upper-Eye designed links are another first for BJ. All the research, testing, and experience gathered in the last twenty years by BJ are used here again for the good of the Industry.

***SHORT-UPPER-EYE* GIVES YOU THESE ADVANTAGES:**

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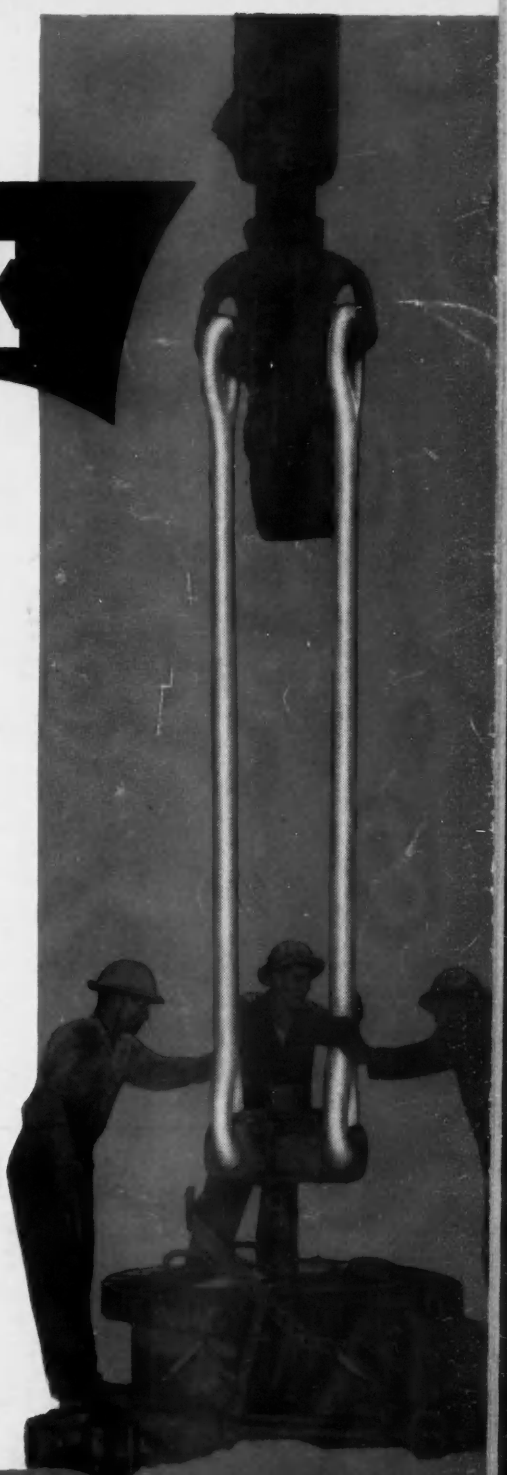
- Allows link to hang in a more nearly vertical position for setting into swivel bail bumpers
- Eliminates hazard of drill pipe or tubing passing through the upper eye if the drill pipe should momentarily hang up while going in the hole

4-TO-1 SAFETY FACTOR. Tentative API standards governed the design of these links. Every link is made to take more than four times its rated load.

A VARIETY OF LENGTHS. The longest link that will fit in a rig should be used, because of the greater handling ease you get with longer links. That's why BJ Small-Upper-Eye Weldless Links are made as long as 132 inches.

Made in 2¼" Diam.—110 ton per link . . . 2¾" Diam.—150 ton per link

In all popular lengths, including 132". Lengths exceeding these will be made on special order only. Will not be made in 1¾" eye section diameter.



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Job No. OW-1-31

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Maximum pressure reached 5,000 PSI.

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WO-U-84

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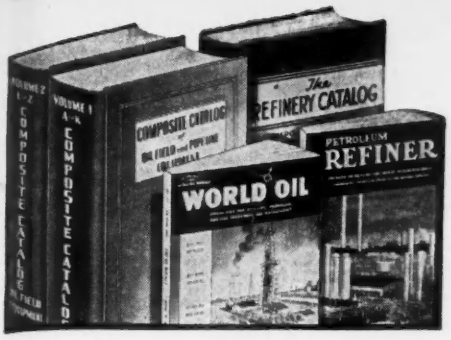

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WORLD OIL and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry

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for the refining-natural gasoline industry

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Don't Pass Up

the opportunity to avail yourself of the wealth of material coming February 15 in the 1948 YEARBOOK-FORECAST issue of WORLD OIL. See pages 276-277.

WORLD OIL

Established 1916 as THE OIL WEEKLY

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HOW TO GET MORE PIPE

LAST MONTH we discussed the steel situation and said (after talking with steel men in the East) that one sure way to get more steel to make more pipe to drill more wells is to get more scrap steel to the steel mills of the U. S. We suggested that great quantities of scrap steel are available in Europe and North Africa and that the practical thing is to bring this steel back to the United States.

IT is possible to increase steel capacity in the U. S. without the tremendous expense necessary to build new mills, the product of which necessarily would have to sell at a price considerably above present steel prices. But in any consideration of the problem of increasing steel production, the scrap question is well at the top of the list. You recall the efforts to get in the scrap during the war, of how the oil industry organized its efforts to bring in scrap and the large amounts of scrap thus recovered and delivered to the mills. That effort, of course, did not bring in ALL of the scrap—but it cleaned out the junk pile on many a lease.

There is, however, this big source of scrap abroad, everyone who has visited Europe has noticed it. So far as is publicly known, no effort is being made to bring this scrap to the U. S. but, on the contrary, European nations have requested, under the Marshall plan, large quantities of scrap to be sent from the United States!

We shall shortly be sending these countries aid in the form not only of food but of manufactured articles. They want dollar credits through exports. *Why in the name of common sense can't we get this scrap back?* Our ships will be going over loaded, and coming back in ballast. Why not bring the scrap back instead of ballast?

IT will take congressional action to bring this about.

Speaking of the desirability of congressional activity along these lines, Alex Walker, president of National Supply Company, in a letter to Secretary of Commerce Harriman, recently wrote:

> "This is a far more intelligent way to secure the additional 5 or 10 million tons of ingots so badly needed, than to build new steel producing capacity costing $2 billion to produce 10 million tons of ingots per year, requiring two or maybe three years to build, and withdrawing 1½ million tons of steel from consumption in other channels.
>
> "I am sure you understand that such action will gradually reduce the price of scrap in America; also the cost of steel; and eliminate the gray market.
>
> "It is my understanding that only the federal government can bring foreign scrap back to this country in large quantities, because the amount owned by private industry, who have the right to sell it, is limited; most of the scrap scattered over this world is owned either by the Army, the Navy, or the nation in which it is now located.
>
> "I know of nothing more that you can do to hasten business stability in America, than to build up the scrap supply and break the gray market which is made possible by the present shortage of scrap and finished steel."

Here, in our opinion, is how you . . . and by you we mean every person who reads this, whether owner, executive or employee of an oil company . . . can help to increase the steel supply in the U. S. and thereby increase the amount of pipe needed by our industry:

Write your congressman and senators and say: "Why don't you do something about bringing scrap steel back from Europe to the United States? This country needs the steel it will make. Only our federal government can do something about it and you are my representative in this matter."

Write the letters today!

Ray L. Dudley

ARE THESE THE QUESTIONS you would ask about any packer?

CAN IT BE DRILLED UP EASILY?—The Baker Retainer Production Packer is completely drillable. You will never have to "mill up" a Baker Packer.

DOES IT RESIST CORROSION?—Yes, the cast iron construction of the Baker Packer is far more resistant to corrosion than the steel casing in which it is set.

IS THE PACKER INSTALLED AS PART OF THE TUBING STRING?—Not the Baker Retainer Production Packer which virtually becomes a part of the casing when it is set. The tubing can be pulled and run-in again as often as is necessary.

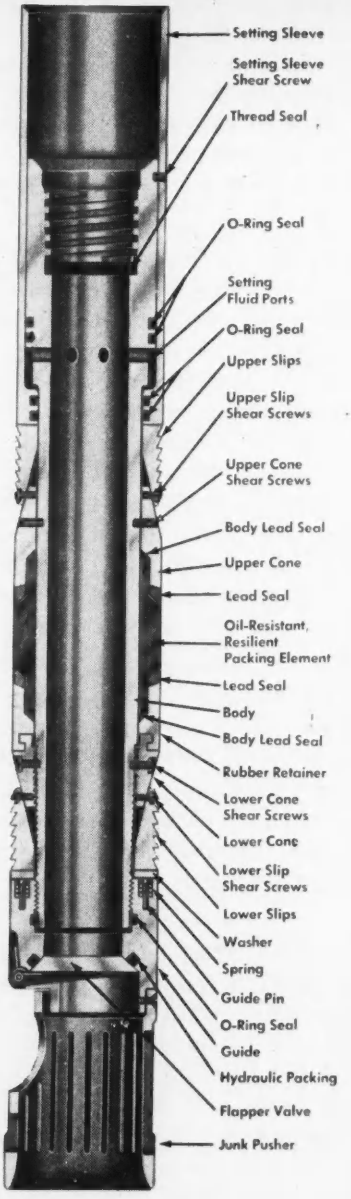
DOES IT HOLD BOTH WAYS?—Yes; Baker Packers are anchored against either upward or downward movement by two full sets of opposing slips.

DOES IT REQUIRE "SET-DOWN" WEIGHT?—When it is desirable, the tubing can be suspended in tension, thus eliminating the possibility of "corkscrewed" tubing which would hinder or prevent dropping pressure bombs, or other similar operations.

DO YOU HAVE TO REMOVE THE PACKER TO GUN-PERFORATE OR CLEAN OUT BELOW IT?—Not the Baker Retainer Production Packer, which is equipped with a positive-sealing, flapper type back-pressure valve. This flapper valve opens readily to permit the downward passage of tubing or tools, but closes instantly to hold safely against back-pressure when the tubing (or tools) are being removed from the well.

IS IT ADAPTABLE TO SEVERAL APPLICATIONS?—Yes; to practically all applications, and to all operating procedures. Single-zone or two-zone hook-ups are possible to meet any production requirement. The Baker Retainer Production Packer also is ideal for water-injection or flooding re-pressuring, re-cycling, testing, acidizing, gas-lift, and many other applications.

WHO MAKES THIS PACKER, AND HOW CAN I GET MORE INFORMATION ABOUT IT?—The Baker Retainer Production Packer (Product No. 415-D) is made by Baker Oil Tools, Inc., and Baker representatives are stationed in all active areas to give you prompt and intelligent service. Get in touch with your nearest Baker man today.



Baker
Retainer Production Packer
Product No. 415-D

BAKER
OIL TOOLS, INC.
Houston • Los Angeles • New York

BAKER
RETAINER PRODUCTION
PACKER

The Changing Panorama

Tires Follow Price Trend of Gasoline

IF THERE is need for further explanation of the paradox of tight supply and record oil production, it can be found in the climbing prices of a companion product—automobile tires.

The U. S. motoring public, which is going farther and staying longer than ever before, has built up a demand which completely fooled the tire-makers and has resulted in an upswing of tire costs.

Last spring the tire makers, anticipating a surplus born of the cessation of military demands, cut prices 10 percent. Then the tourist season last summer hiked the demand 10 percent above 1946, and the rise in labor and material costs trimmed the tire manufacturers' profits. To meet the situation, General Tire & Rubber Company hiked prices 7½ percent in November. Last month Goodrich, Goodyear Firestone and U. S. Rubber fell in line with increases ranging from 5 to 8 percent.

Is Venezuela Holding Back on Production?

THE STRANGE, and perhaps unjust charge that Venezuela does not want to increase its oil production was heard with increasing frequency by WORLD OIL staff writer George O. Ives on his recent South American tour that consumed 20,500 miles and three months.

Never aired in the newspapers or at public meetings of responsible persons, this report—so incredible on the face of it to the oil industry in a free-enterprise nation—could not be accorded more attention than is usually given office and cafe gossip were it not for the frequency it was heard from the lips of men who are no idle rumor-mongers.

The charge circles around speculation as to when, or if, the government will offer more lands for exploration. No move has been made in this direction since the Revolutionary Junta came into power in October, 1945, and this despite the certainty that a call for bids would create a scramble among well-heeled bidders. The only reason given is that the government wants an opportunity to review the effect of the 1943 oil law and how it was working. Many think this a rather feeble excuse.

Among the many possible explanations of the delay in offering new lands, two are most frequently heard. First, the government may be harboring the hope of prolonging the country's productive period; and second, little additional revenue accrues to the government with increased production because of the comparatively low purchasing power of the dollar.

With the change in administration early in 1948, there may be a change in policy. Meanwhile, new companies must be content with picking up acreage from those already holding it.

Roumania Joins Rush For U. S. Equipment

COMMENTING on Roumania's application for $7 million worth of oil field equipment from the U. S., Russell Brown, general counsel of IPAA, says:

"The renewal of authority to license exports will doubtless be strongly advocated in the immediate future. The Secretary of Commerce has already made such recommendation. The present authorization expires February 29, 1948.

"Insofar as the operations of the Act have affected the steel supply needed for the domestic oil industry, there is nothing to be said for its renewal. The State Department and others in government have worked untiringly in behalf of Middle East development at the expense of our own.

"Now, it seems, Roumania has been inspired by the actions of our State Department to seek a large amount of steel, including drill pipe. It would indeed be abject surrender of national interests to use the control act for the benefit of that Moscow-dominated country.

"The American oil industry should exert its efforts to see that this particular license is not granted."

Establishment of a synthetic fuel industry should not be delayed until an emergency period arrives. The need for a synthetic supply is emphasized by the fact that the oil industry during the war lost its former million-barrel-per-day excess of producing ability.

W. C. SCHROEDER,
Chief of Office of Synthetic Liquid Fuels, U. S. Bureau of Mines

Blood in Palestine; Camel Corps Drama?

BLOOD CREEPS across the sands of partitioned Palestine, and where or whether it stops means much to the oil industry and perhaps everything to world peace.

There are those who say the violence will be quelled without an all-out war between the Arabs and Jews; without the intervention of U. S. troops; without involving Russia, so strangely eager to partition the Holy Land; and thus without seriously disturbing American investments in Middle East oil.

Among those looking at the picture from this rosy angle is *Collier's,* and we quote from the November 29 issue: "As for the Arab League's loud talk about a holy war, we think that can be pretty heavily discounted; and the same as to Arab hints about cutting Middle East oil pipe lines. The Jews have excellent fighting organizations in Palestine now, if it comes to that; and the Arabs are hardly likely to break off with their American and British oil customers, from whom the Arab potentates get their biggest revenues."

Among those taking the darker view is WORLD OIL's Henry Ozanne, whose gloomy predictions have thus far proven correct. He wrote in mid-October: " . . . we are up against a determination on the part of 30 million people of the seven Arab League states that can't be laughed off as the mere melodrama of a desert camel corps.

"The complete loss of U. S. trade and industry revenue would scarcely disturb the national economy of Iraq, Saudi Arabia, Syria or Transjordan. In Saudi Arabia, for example, the $75,000 daily income from the Aramco production is the personal 'take' of King Ibn Saud; it is not national wealth in any sense that we understand the term."

We hope that the final issue of war or peace does not rest upon *Collier's* argument that the Arabs will refrain from reprisals for reasons financial. Seventy-five thousand per day in the jeans of Ibn Saud hardly seems a formidable barrier against the hatred, resentment and religious frenzy of those wild desert legions who never see any of the money themselves.

HINDERLITER

"Better Built" WELL-HEAD EQUIPMENT

for High and Low Pressures

Money DOES Grow on Trees

Yes, you can count as tangible profits the savings that accrue to you in time, money and labor when you use HINDERLITER assembled, tested, and certified Christmas Trees.

Completely shop-assembled around the famous HINDERLITER well-head equipment, HINDERLITER trees offer a high degree of labor-saving flexibility, time and wear-resisting ruggedness, and above all, *safety* and dependability in the emergencies. Tested to API standards with a high factor of safety, they are also certified, in accordance with AWHEM code of recommended practices.

HINDERLITER Custom-Built Christmas Tree Assemblies are designed to your individual needs for all recognized pressures. For a safe investment in well-head control, specify HINDERLITER, the pioneer in accepted well head design.

Photo shows typical Hinderliter installation on one of the Rogers Lacy leases in the high-pressure Carthage gas-distillate field of Panola County, Texas. Assembly includes a Hinderliter #DV-1A Ram Type Blowout Preventer, 5,000 pounds test pressure.

HINDERLITER TOOL COMPANY Division

H. K. PORTER COMPANY, Inc.

Tulsa, Oklahoma — Pittsburgh, Pennsylvania

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MONTHLY NEWS ANALYSIS

McCARTHY MAY ENTER ARGENTINA . . . CRUDE PRICE HIKE REFLECTS TIGHT SUPPLY . . . INDUSTRY ASKS PUBLIC TO AVOID WASTE . . . OIL DEMAND HEIGHTENS CASING NEED

McCarthy-Peron Deal Awaits Argentine Cabinet's Approval

There was considerable talk during the past month in American oil circles over the possibility that Glenn H. McCarthy, successful Texas independent operator, was about to conclude a deal whereby he would carry on an extensive exploration and development campaign in Argentina for the government (see Page 224).

After news reports from Argentina indicated papers there were giving considerable publicity to the plan, McCarthy announced that he had submitted a $290 million plan to President Juan Domingo Peron in November, and at the time President Peron unofficially had accepted the plan. However, McCarthy emphasized that final acceptance of the plan by Argentina was to await conferences between President Peron and his cabinet.

The plan submitted embraces development in all phases of Argentina's program, from exploration and development through transportation, refinery construction and research in petroleum chemistry. It was to be placed in effect early in 1948, but McCarthy indicated he was not speculating on just how long it might take to complete the program, other than that it would fit well into Argentina's Five-Year Plan.

Significance was attached to the reported feeling on the part of the Argentine government that the American wildcatting system successfully used by McCarthy was a desirable thing, and that the government preferred operations in the hands of an American independent rather than in the hands of one or more of the big companies already operating in the Argentine. However, it is doubtful if a major company would contract to carry on an operation of the type being considered between McCarthy and Peron.

Meanwhile, significance also was being attached to the talk made by Peron on December 13, the occasion of the 40th anniversary of the discovery of the Comodoro Rivadavia field, principal producing area of Argentina. He pointed out that Argentina was now producing only 40 percent of its requirements and having to import the remaining 60 percent, and spoke of ways and means of augmenting its sources of energy and power to support its industrialization program.

He stated that the petroleum policy of Argentina has been based on the same principles upon which rest all of the economic policy of the nation, that Argentina sovereignty was to be retained over the riches of her subsoil, with rational and scientific exploitation on the part of the state. He warned that when the state takes over the immediate and direct guidance of the resources it possesses, it must not then relinquish the right to administer the same, dividing its functions with other interests which are not following those of all Argentinians.

From his statement it appears that Peron is giving assurance that the state will retain control of the industry and its administration without saying that outside aid will not be solicited in getting the most from its potentialities.

Sharp Rise In Oil Prices Reflects Tight Supply

Current difficulties the industry is experiencing in producing enough crude oil to meet soaring consumer consumption of petroleum products resulted during December in the sharpest crude oil price advance in years—50 cents per barrel. Despite considerable opposition by larger companies to further advances in crude prices, and particularly to one of such size, competing purchasers found it impossible to refuse to meet the new postings.

Initiated November 28 by Sun Oil Company, the 50-cent raise was generally met by December 6 throughout the Mid-Continent, Rocky Mountains and Middle West, and extended even to the Appalachian fields and into Canada, while it resulted also in a 40-cent increase in California.

The payment of premiums above posted prices had preceded the price raise, and was the underlying cause of the advance. However, it soon became apparent that the new prices were not to stop the payment of premiums by concerns hard up for crude supplies. Several immediately offered more than the new posted prices.

Additional details on the crude price situation are presented on page 33.

Refined Products Prices Also Are Advanced

The inevitable and prompt sequel to the crude price increase was a proportional increase in prices of refined products. Refiners were confronted with an increase of 1.2 cents per gallon in the price of their raw material, with a 42-gallon barrel up 50 cents. Some products were advanced at the refinery by approximately this same amount, though gasoline was raised as much as 1½ cents a gallon and residual fuel oil as little as 38 cents a barrel, or less than the increase for crude from which it comes.

So irresistible have become the swirling currents of inflation that even lubricating oils, sold by the quart and not so sensitive to market trends as gasoline and other products, have had to be marked up. One company said at the middle of December that it was raising retail prices of motor oil for the first time in more than ten years. The revision was necessary, it said, to meet steep advances during the last three years in materials and production costs and to defray increased expenses of operating retail outlets. It cited increases in costs of containers, steel drums, lithograph cans, and cartons, ranging from 33 to 48 percent, a 35 percent rise in transportation costs, and increases of over 75 percent in cost of crude oils. In the last two years, the company stated, overall refining costs have risen approximately 60 percent and labor costs involved in production, manufacturing,

and retail distribution have increased considerably. Top grade of lube, which had been selling for ten years at 35 cents a quart, was raised to 40 cents; next grade, which had been 25 cents since 1933, was raised to 30 cents; and 20-cent grade was raised to 25 cents; while two-gallon cans of another grade were raised from $1.25 to $1.40. These prices all included the present federal excise tax of 6 cents a gallon.

Oil Companies in Odd Role of Asking Less Use of Oil

Among numerous other oddities of this postwar era is the apparently irrational yet quite sensible situation in which oil companies are asking for less rather than increased use of their products.

Through individual company advertising, personal contacting of the people, and other company efforts, as well as through publicity and other efforts of the American Petroleum Institute, the industry is actively trying to get the public to do its part toward making available oil supplies satisfactorily meet essential requirements.

Emphasis is placed on the fact that the consumer can save money by avoiding wasteful or excessive use of petroleum products. In the case of fuel oil for heating homes, for example, it is pointed out that fuel and money can be saved by putting and keeping the furnace in efficient working condition; weatherproofing the home, which may cut heating cost as much as 50 percent; avoiding overheating of the home; keeping enough moisture in the air, which makes one comfortable at lower temperatures; closing flues in unused fireplaces, which suck out warm air; closing off unused or seldom used rooms from rest of house; closing doors to rest of house when bedroom windows are opened at night; heating garage no more than to 40 degrees to protect car.

The chief hope of easing the present tight supply situation for petroleum products, points out one large company, lies with individual consumers, many of whom are unconsciously wasting tremendous amounts of fuel. It cited a survey of 75,000 homes made early in December, showing that the average fuel oil consumer keeps his thermostat set at 73 degrees during the day, and that only half of the consumers turn the thermostat down at night—and then only to 65. It is possible to save more than 10 percent on fuel, and thus meet allocation figures to which some suppliers have resorted, said the company, by making just two changes in habit: (1) never set the thermostat above 70 and keep it lower if possible; (2) reduce temperature at night, setting the thermostat at 60. These rules alone, it said, will greatly help to assure that consumers will avoid inconvenience this winter and that everyone can be provided with essential amounts of fuel.

Fuel Conservation Urged

Through company advertising, personal contact, and otherwise, oil companies are endeavoring to get the public to do its part toward satisfactory balancing of oil demand and supply by eliminating waste and unnecessary consumption. Here Bruce R. Walsh, head of the fuel research laboratory of Gulf Oil Corporation, Pittsburgh, visiting an average home, tells the head of the house that he can conserve fuel, save money, and yet stay comfortable by having his furnace serviced by a competent mechanic and thus getting maximum efficiency from it.

The strained supply conditions this winter obtain primarily in the Eastern and Midwestern sections of the country, partly because those regions have to bring in large proportions of their needs from sources elsewhere and partly because they have such large requirements for heating oil during cold weather; this demand having been inordinately increased in recent years by widespread shifting from coal to oil for heating, and by the numerous installations of oil burners in new and old homes.

Large Oil Demand Makes Need for Casing Urgent

Continued expansion of demand for petroleum products foreshadows a record demand in 1948. To an earlier forecast for 1948 by the U. S. Bureau of Mines have been added two subsequent surveys, one by the Interstate Oil Compact Commission and the other by the Independent Petroleum Association of America.

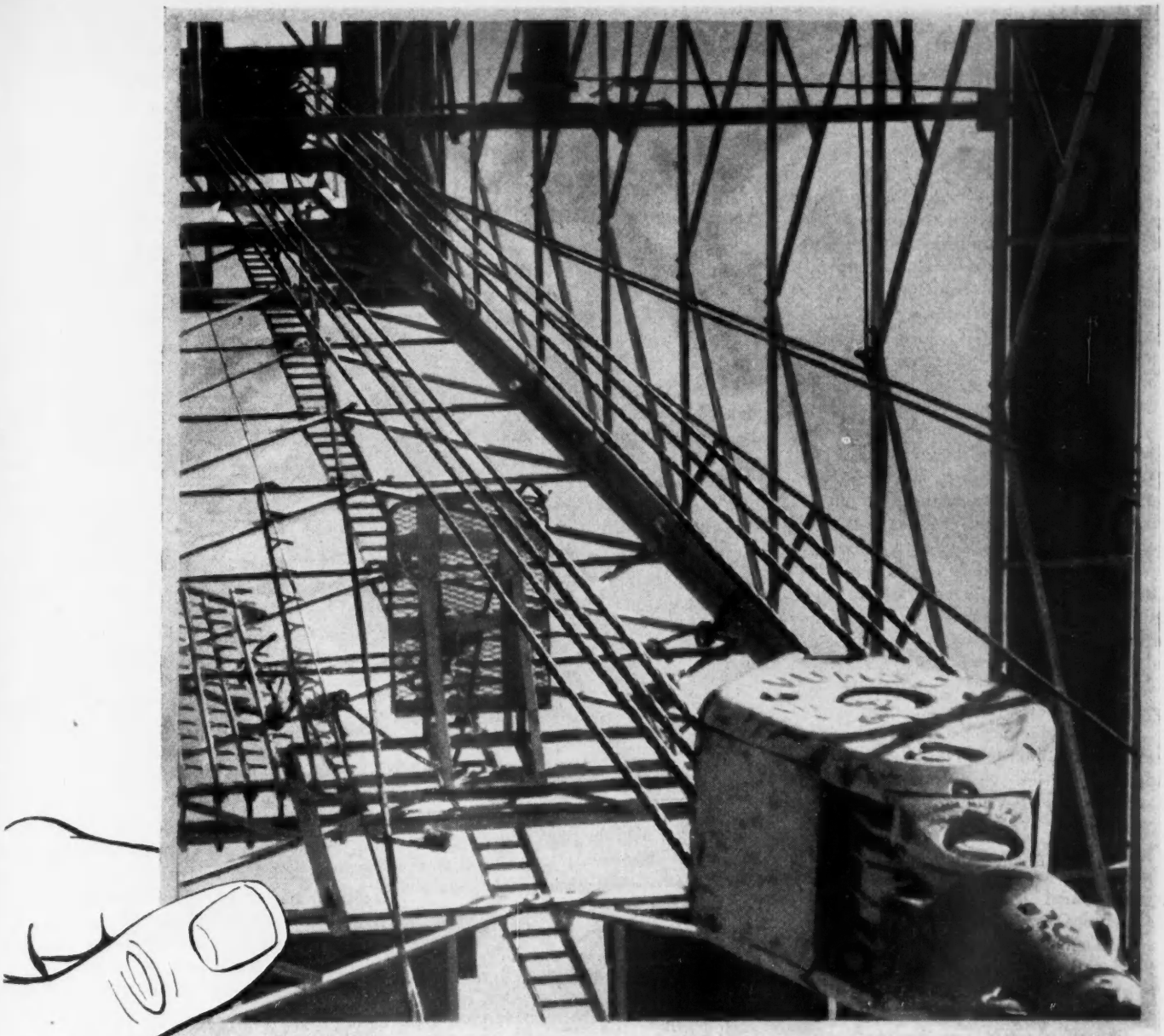
The economics advisory committee of the Interstate Oil Compact Commission has forecast that demand for petroleum products in 1948 will be 6,195,000 barrels daily, 6 percent more than in 1947 and about 40 percent more than in 1941. This estimate included an allowance of 400,000 barrels per day for exports. Refinery runs of crude to stills must average 5,375,000 barrels daily for 1948 to meet this estimate of demand, it was calculated.

In the first quarter of 1948, the Compact committee estimated, demand will total 6,295,000 barrels daily, assuming normal weather, compared with 5,917,000 daily in the initial quarter of 1947 and 4,107,000 daily in the first quarter of 1941. This high demand will necessitate drawing on stocks, the committee said, and will require tremendous effort in the industry, excellent coordination, and favorable conditions generally to attain the necessary yields and to transport and distribute supplies so as to minimize temporary local difficulties. The committee was hopeful that the high demand could be met satisfactorily by proper cooperation of the industry and consumers. It allowed for only a moderate increase in oil burner installations and allowed for residual fuel oil demand no greater than supply, pointing out that many residual fuel oil consumers could use coal even though they would prefer fuel oil if it were available.

Prompt utilization of idle tankers in the hands of the government was declared by the committee as one of the essentials in taking care of demand.

Meanwhile, the supply and demand committee of the Independent Petroleum Association of America forecast that domestic production of crude oil would be required at the rate of 5,330,000 barrels daily in the first quarter of 1948 and at the rate of 5,440,000 barrels per day in the second quarter. Pointing out that domestic production was currently averaging about 5,280,000 barrels daily, the committee said this forecast indicated the industry would have to increase crude production by 50,000 barrels per day for the first quarter and by an additional 110,000 barrels daily for the second quarter.

To supply the prospective great demand for petroleum products, asserted the IPA committee, it is highly urgent that the industry be able to procure increased supplies of steel goods and other materials. The estimated requirements for domestic production in the first half of 1948 are approximately 70 percent above the average of the five prewar years 1935-39, said the committee, whereas production of steel casing and drill pipe shows only a very slight increase, while there is now a greater than prewar proportion of such steel goods production being exported.



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Industry Confronted With New Wage Increase Demands

The peak of inflation is not yet in sight. Commodity prices lately have climbed to new postwar highs, nearly equaling the peak of 1920, with crude oil and petroleum products going up along with virtually all the others. Now that prices have made a new spurt upward, wages seek to make an upward jump.

The Oil Workers' International Union, affiliated with the CIO, proposes to follow the recent oil price advances with increases in wages in the industry. The union's national wage policy committee is scheduled to meet shortly after January 1. According to its president, O. A. Knight of Fort Worth, the union will then consider the "situation precipitated by the inflationists in oil and other monopolistic industries," and draw up a wage program. He inferred that further wage increases would be demanded, although the amount of increase remains to be determined.

The most significant thing about Knight's December 15 public statement, serving notice of the impending wage increase demand, was the spirit of it, which was hostile to business in general and denunciatory toward oil companies, as voiced in the above quotation. This attitude did not offer high promise of harmonious relations in 1948 between the union and oil company management. The attack against oil companies was timed with and tied to the 50-cent crude price increase. The increase was, of course, a pertinent development to cite in building up justification for a new wage increase demand, after claiming that the oil workers' union previously had been urging members to hold off on new wage demands in harmony with CIO's policy.

However, the mere fact of new increases of prices in general including oil prices made strong argument for wage increases and made it seem beside the point and superfluous to go on to argue that the crude raise was not justified and that the increase was made through monopolistic power.

Still in progress at the midde of December was the eight-months-old strike of the Oil Workers' International Union at The Pure Oil Company refinery at Toledo.

Around the beginning of December a number of Oil Workers' International Union locals in Southern California, at refineries of Standard Oil Company of California and of Shell Oil Company, came to agreements with those companies, calling for increases in wages. But these were described by the OWIU president as of only local significance because Pacific Coast contracts were generally below the level for the rest of the country. While the California agreements are not expected to affect negotiations elsewhere, they will be in effect on the West Coast until August 31, 1948.

Prophecy of Middle East Ascendancy Coming True

The prophecy in 1944 of the U. S. Technical Oil Mission to the Middle East that the "center of gravity of world oil production is shifting to the Middle East" is being accurately fulfilled.

Since that report was written, work and planning have proceeded on Middle East pipe lines and other oil projects that will cost hundreds of millions of dollars and go far toward making the fabulous petroleum reserves of the area available to international markets.

On top of the vast program of pipe line construction previously announced, there has come recently a report that still another huge pipe line is contemplated—from Kuwait to the Mediterranean.

Meanwhile, however, the lines now under construction are meeting serious obstacles which could materially delay originally expected operating dates. Much objection has arisen in the U. S. to the shipping of pipe and other materials to the Middle East under the present steel shortage.

Besides the problem of obtaining materials and equipment, the projects were confronted in late December with the new problem of smoldering antagonism because of the U. S. part in partitioning Palestine.

Meanwhile, the great prospective importance of Middle East oil to the whole world was emphasized by further indications that at least some of it eventually will be used in the U. S. Several companies have brought in shipments of the crude for test runs in East Coast refineries. In connection with the recent 50-cent U. S. crude price increase, Sun Oil Company, which initiated the advance, stated it had tried unsuccessfully to purchase Middle East oil. This suggested that henceforth potential imports from the Middle East will be an increasingly important factor in determining what levels will prevail for crude prices in the U. S.

So important is the potential influence of Middle East that it is being taken into consideration in forecasting petroleum supply and demand even in California. With California facing the possibility of needing to supplement its own production within a few years, some think the West Coast may come to bid against the East Coast for Gulf Coast or Caribbean crude and result in the East Coast turning to the Middle East for a part of its requirements.

Public To Be Told What Is Causing Shortage

Fearing public misunderstanding of the current oil shortage might result in adoption of ill-considered governmental policies, the industry last month set out to explain the situation to U. S. citizens. During the next few months much of the industry's joint public relations work, as well as individual company advertising, is to be devoted to this purpose.

It is to be emphasized that the oil industry is doing its best to supply all needs for oil and is supplying products at rates well above the wartime peak. It is to be stressed that the industry is operating under serious handicaps, and for the time being, cannot fully keep abreast of demand, which is continuing to increase at an overwhelming rate.

Chief reasons for the great demand are listed as the increasing number of cars, trucks, and busses; increased mechanization of farms; increased use of diesel engines; and sharply increasing numbers of domestic oil burners, as evidenced by the setting of an all-time monthly record of 101,000 central heating oil burner installations in homes in October, most of these setting up new demand.

Since June, 1941, demand for distillate fuel oil, including home heating and diesel fuel, has increased more than any other major petroleum product. While gasoline demand is up 19.5 percent since then, distillate fuel oil needs have increased 67.5 percent, according to one statement. Since the end of the war, alone, demand for fuel oil has gone up 50 percent. This winter's fuel oil requirements are estimated at 25 percent above last year. In the first eight months of 1947, 500,000 fuel oil heating units have been sold, equaling the original estimates for the whole year and far above the highest previous annual sale. No letdown in the rising trend of demand is indicated, as a recent poll showed heat preferences of new home owners in this order: oil 45 percent, gas 33 percent, and coal 8 percent. Demands for other petroleum products are up also, making total demand show an increase of 10 percent for 1947. In the case of distillate fuel oil, requirements for all uses have increased.

The handicaps which make it unusually difficult for the industry to meet these tremendous demands are cited by the oil companies as including particularly the shortages of materials. Lack of materials, chiefly steel and such steel products as pipe, has made it impossible, it is explained, to complete necessary new pipe lines, new tankers, and new refineries to take care of enormously expanded requirements for oils.

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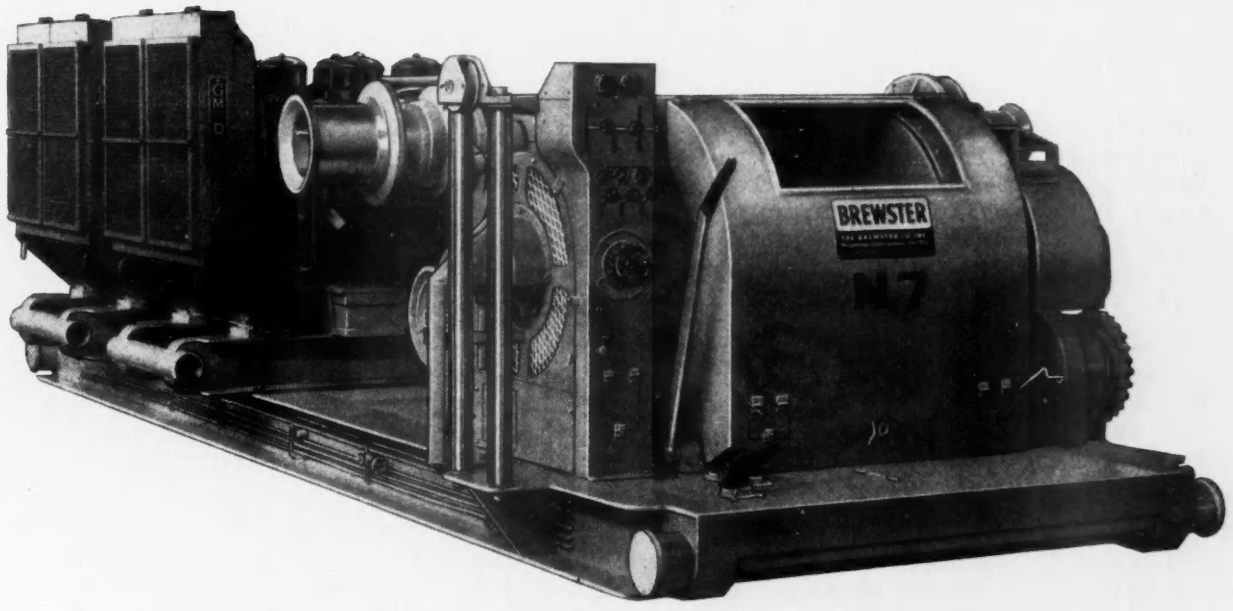

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Looking Ahead

THE FIRST STEP toward possible expropriation of U. S. and British oil properties behind the Iron Curtain was taken with the seizure by Roumania of British Astra-Romana and Unirea companies. American companies will sit tight but pour no more money into Roumania. It is understood this conforms with State Department's ideas. Eventually, the entire Roumanian investment may have to be written off. Meanwhile, operations are virtually suspended.

TO PREVENT necessity of bringing 105,000 barrels of oil daily into California by 1952, says R. L. Minckler, executive vice president of General Petroleum Corporation, industry must increase discovery rate, using new methods; get greater recovery from reservoirs; use secondary recovery in old fields; employ new production methods for known reserves that are now being recovered.

PROBABLY IN JANUARY, Congress will consider legislation to guide national rubber policy after expiration of existing laws. Some rubber industry men recommend that required use of 1/3 synthetic with 2/3 natural rubber be continued; that government maintain standby annual capacity of 600,000 tons of synthetic and stockpile of 300,000 to 800,000 tons. Views differ on whether government plants should be sold to private companies.

CONTINUANCE of heavy taxation in 1948 is fairly certain in absence of more howling by public against costly bureaucracy. To "condition" public for thinking in even larger sums than a year ago, dispatches from Washington have said President Truman may present a $40 billion budget to Congress. Argument over European aid of perhaps $6 billion probably will be counted upon to draw fire away from the extravagant remainder.

INDUSTRIES generally deprecate current threats of return to allocations, rationing, and price controls. But it is not safe to assume that controls can be staved off unless business men aggressively deny soundness of controls and convince public that controls would be damaging, not beneficial.

IF PUBLIC gets oil controls and resultant shortages, it will do so against advice and warning of Russell B. Brown, of Independent Petroleum Association. He asserts: "Those who have argued for controls have not said that controls would add one barrel of new products to our present supply. They have not shown any improvement in supply through controls. The best they offer is a more thorough denial of products to those who want them."

PRICES in general seem to be approaching position of president who lamented there was no place for him to go in future except down. By early December, price index, still climbing and setting new records since early 1920's, was close to 160 percent of 1926 and within few points of 1920 peak.

EAST TEXAS field, best yet in the U. S., now 17 years old, still has reservoir pressure of 1,000 pounds, says Ernest O. Thompson, Texas Railroad Commission Chairman, and will produce in future 2 to 3 billion barrels more. This would make ultimate recovery about 4½ or 5½ billion barrels, as field already has produced 2.6 billion. High recovery results from scientifically controlled production. Original estimates, assuming old production methods, placed ultimate at only 1 billion barrels.

INDUSTRY LARGELY MEETING DEMAND

DESPITE SHIFTS FROM COAL TO OIL

By H. C. WIESS
President, Humble Oil & Refining Company, Houston

INSTEAD of apologizing for difficulty in meeting abnormally high postwar demand, the oil industry should demand credit for an amazing job of producing above the wartime peak and one-third above prewar, despite handicaps. All but 2 or 3 percent of oil requirements are fulfilled, and this deficiency would not exist if it were not for much current use of oil in lieu of coal and European demands on U. S. oil and coal.

THE principal explanation of the relatively tight supply situation now existing for petroleum products, even though supplies exceed those in World War II, is indicated by the accompanying summary of U. S. energy production, based on official statistics of the Bureau of Mines.

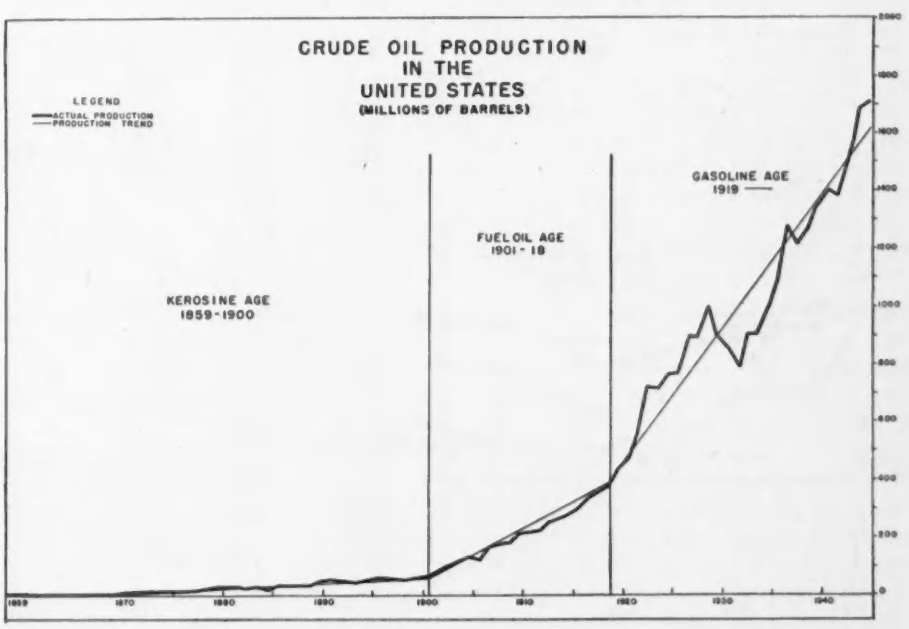
The present situation has been caused by a rapid shift from coal to oil for heating and has been aggravated by the European fuel shortage and the heavy demands on the U. S. for coal and oil to offset this shortage. As shown by the statistics herewith, oil and gas have supplied practically all of the additional energy produced in the U. S. since 1920, while coal production declined. Between 1941 and 1946, the shift to oil was encouraged by price controls on oil and gas, while coal prices were permitted to advance further. The U. S. oil industry is already operating at capacity under current conditions, and cannot carry the entire load of additional requirements for fuel, particularly in this period when Europe is producing only a fraction of its needs. It is high time and very important that all concerned realize this situation. When the facts are understood, I hope the industry will no longer be criticized or blamed for possible minor shortages if they occur.

The rapid growth in demand for petroleum products is due largely to the fact that coal has not been available and that oil products have been low-priced in relation to coal. This conclusion is indicated by the changes in demand in the period 1941-46 when the increases in demand were 40 percent for distillate fuel oil, 25 percent for residual fuel oil, 10 per cent for gasoline, and an average of 20 percent for all petroleum products. In 1947 demand has continued to grow rapidly and the gain over 1946 will amount to about 20 percent for heating oils and 10 percent for all petroleum products. Such large increases in demand simply reflect the fact that nearly all of the additional load for energy requirements is still being thrown on oil.

Oil and gas now supply substantially as large a part of U. S. energy requirements as coal. The potential reserves of oil and gas, however, are much smaller than of coal, being measured in scores of years in one case and in hundreds of years in the other case. Because the oil industry has been efficient and has supplied its products at low cost, there has been a major shift to the consumption of oil during the past 25 years. Unless additional oil-producing capacity is developed soon in the Western Hemisphere, further conversions to oil will necessarily be retarded or stopped.

The U. S. is fortunate in having available large supplies of both oil and coal and in the benefits which it has realized from the competition between these fuels. The operation of demand and supply forces in a competitive fuel market will normally tend to establish a price relationship between oil and coal which recognizes the premium value of petroleum products. Oil is particularly suited for use in transportation and as a lubricant. If it is used too rapidly as fuel for stationary industrial equipment and for heating, the day will be hastened when the public will have to pay the high cost of making synthetic fuels from coal.

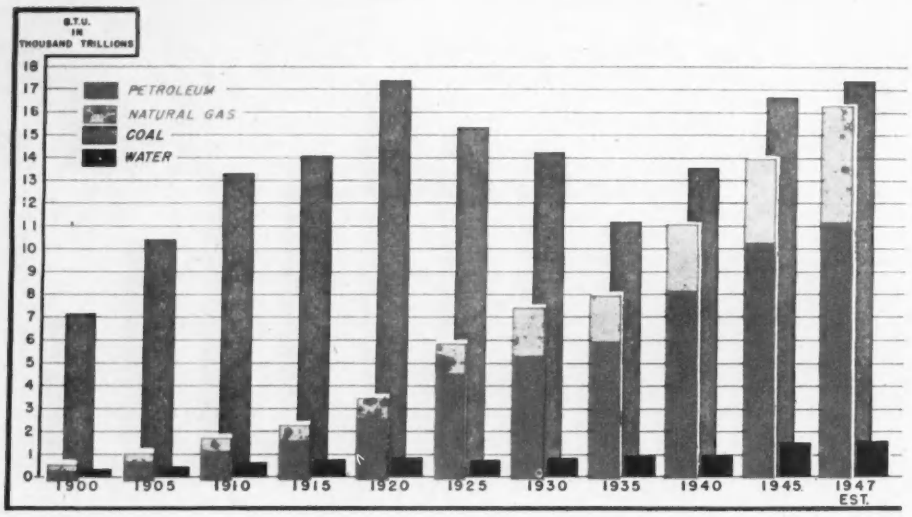
The oil industry is supplying an average of 600 gallons of petroleum products per capita in the U. S. this year, compared with about 20 gallons for the rest of the world. Such a relationship makes it difficult to conceive of a logical basis for criticism of the performance by the petroleum industry. I trust



An analysis of current tight oil supply situation, as set forth originally in a letter to Secretary of Interior J. A. Krug and as embodied in a speech at a banquet of the Humble Club, organization of employes.

U.S. ENERGY PRODUCTION

INCREASE IN OIL & GAS TO EQUAL IMPORTANCE WITH COAL



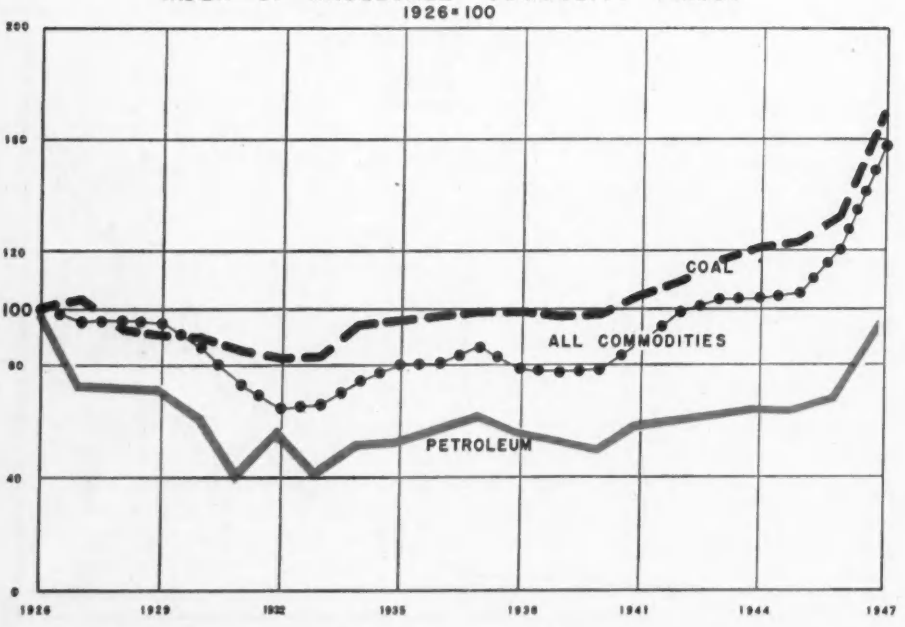
U. S. Production of Energy Resources
(Based on official statistics of the U. S. Bureau of Mines)

	1920	1941	1946
Coal-Million Tons	658.2	570.5	593
Crude Oil-Million Barrels	442.9	1,402.2	1,733
Natural Gas-Billion Cu. Ft.	798.1	2,812.7	3,900*

	TRILLION B.T.U.			PERCENT OF TOTAL		
	1920	1941	1946	1920	1941	1946
Coal	17,336	15,004	15,600	80.3	54.8	49.3
Crude Oil	2,658	8,413	10,500	12.3	30.7	33.1
Natural Gas	858	3,024	4,200	4.0	11.0	13.2
Water Power	738	934	1,400	3.4	3.5	4.4
Total	21,590	27,375	31,700	100.0	100.0	100.0

INDEX OF WHOLESALE COMMODITY PRICES

1926=100



that you will agree that the oil and gas industry is doing an amazing job in meeting such a large part of the energy requirements and in having increased production by one-third during the last six years in spite of shortages of steel. In view of the load which has been placed on the petroleum industry, it is remarkable that supplies will be adequate to meet all of the demand except perhaps 2 or 3 percent, at worst, whereas shortages in a number of large industries are much more serious.

An indispensable measure to conservation of petroleum products is the production of more coal. Such shortages of fuel as may develop this winter will be due to lack of adequate coal production and certainly should not be considered any reflection on the outstanding performance of the petroleum industry. The record of performance does not justify or excuse any regimentation or control of the oil industry. In fact, the record of achievement during and since World War II is assurance that the oil industry will take all reasonable steps within its power to deliver maximum supplies to consumers.

Energy Production in the United States
(Trillion BTU)
Increasing Proportion from Oil and Gas

YEAR	Coal	Domestic Crude Oil	Natural Gas	Water Power*	Total Energy
1900	7,123	382	254	250	8,009
1901	7,752	416	283	264	8,715
1902	7,943	533	301	289	9,066
1903	9,437	603	319	321	10,680
1904	9,291	702	333	354	10,680
1905	10,367	808	377	386	11,938
1906	10,922	759	418	414	12,513
1907	12,671	997	437	441	14,546
1908	10,978	1,071	432	476	12,957
1909	12,155	1,099	517	513	14,284
1910	13,226	1,257	547	539	15,569
1911	13,096	1,323	551	565	15,535
1912	14,088	1,338	604	585	16,615
1913	15,025	1,491	626	609	17,751
1914	13,545	1,595	636	636	16,412
1915	14,018	1,687	676	659	17,040
1916	15,548	1,805	810	681	18,844
1917	17,166	2,012	855	700	20,733
1918	17,868	2,136	775	701	21,480
1919	14,602	2,270	802	718	18,392
1920	17,336	2,658	858	738	21,590
1921	13,358	2,833	712	620	17,523
1922	12,551	3,345	820	643	17,359
1923	17,331	4,394	1,083	685	23,493
1924	15,064	4,284	1,228	648	21,224
1925	15,306	4,582	1,278	668	21,834
1926	17,319	4,625	1,411	728	24,083
1927	15,744	5,407	1,553	776	23,480
1928	15,169	5,409	1,686	854	23,118
1929	16,025	6,044	2,062	816	24,947
1930	14,136	5,388	2,089	752	22,365
1931	11,633	5,106	1,813	668	19,220
1932	9,470	4,711	1,673	713	16,567
1933	10,089	5,434	1,672	711	17,906
1934	10,970	5,448	1,904	698	19,020
1935	11,175	5,980	2,060	806	20,021
1936	12,989	6,598	2,330	812	22,729
1937	13,083	7,675	2,588	871	24,217
1938	10,387	7,286	2,468	866	21,007
1939	11,745	7,590	2,663	838	22,836
1940	13,472	8,119	2,860	880	25,331
1941	15,004	8,413	3,024	934	27,375
1942	16,908	8,320	3,282	1,136	29,646
1943	17,113	9,034	3,671	1,304	31,122
1944	17,966	10,067	4,064	1,301	33,398
1945	16,576	10,267	3,662	1,399	31,904
1946†	15,600	10,500	4,200	1,400	31,700

* Prevailing central station equivalent. † Estimated.

HIGHER CRUDE PRICES SHOULD *Stimulate* SUPPLY

By L. J. LOGAN
Associate Editor

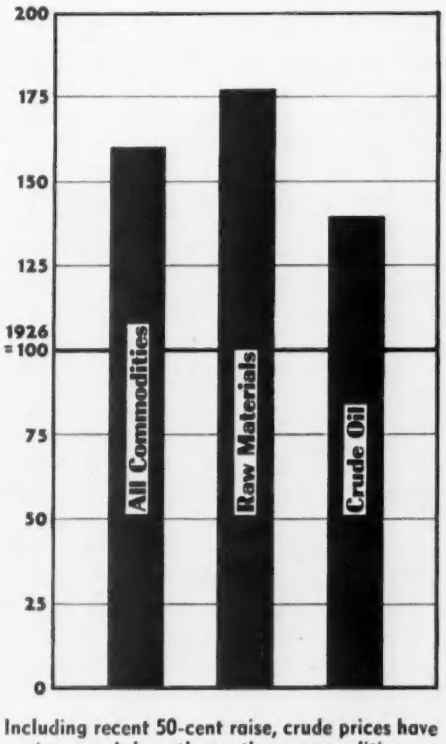
THE NET RESULT of controversy over merits of crude raise is a general 50-cent increase and proportional advances of product prices. Because of better price, stimulation of production and saving of reserves are forecast. Including latest increase, price of crude oil has increased relatively less than prices of other commodities.

BY mid-December the petroleum industry had generally adjusted itself to a new price structure, from coast to coast, and from well to service station, following Sun Oil Company's bombshell initiation of a 50-cent-per-barrel crude raise November 28.

This development showed that the petroleum industry cannot avoid the problem of inflation and high prices any more than other industries can. It also demonstrated the influence of supply shortages on prices. General conditions being what they were, there was no reason for great surprise over a crude raise occurring at this time. In fact, WORLD OIL had predicted the advance. For some time, small purchasers had been paying sizeable premiums above posted prices because of difficulties they encountered in getting enough oil. Again, there was nothing startling about this situation of premium paying, it being the traditional way of small refiners to obtain supplies when requirements exceed production. The only surprise connected with the raise was the size of the advance. While there was considerable opposition to any further raise at all in crude prices, the 50-cent increase initiated by Sun drew extra fire because of its unusual amount.

The raise was met generally in the Mid-Continent, Rocky Mountain, and Middle Western regions by about December 6, when reluctant purchasers tired of losing well connections to Sun and various smaller purchasing companies that took the lead to the higher price level. Pennsylvania grade crudes went up 50 cents at the same time. Even earlier, a 40-cent raise was the result on the West Coast, Union Oil Company of California having initiated such an increase December 1. By December 12 the effect had spread to Canada, as Turner Valley and Leduc crudes were raised 50 cents a barrel, while some other crudes were raised in lesser amounts.

With many refiners purchasing substantial proportions of their crude requirements from others, the necessity of raising refinery prices of petroleum products to cover the increase in crude cost was obvious, and such increases were promptly announced. Different refiners raised their wholesale prices of products by different amounts, with ideas varying considerably on what products should be raised by how much in compensation for the higher crude cost. Probably representative of the product price increases, although less than for some companies and more than for others, were those announced December 10 by Standard Oil Company (Indiana), large Middle Western wholesaler. That company raised tank wagon prices of gasoline 1½ cents a gallon, kerosine and distillate fuel oil 1-3/10 cents a gallon, and residual fuel oil 1 cent per gallon, effective in 11 states. The crude raise of 50 cents per barrel of 42 gallons was equivalent to an extra raw material cost of 1.2 cents per gallon for the refiner.

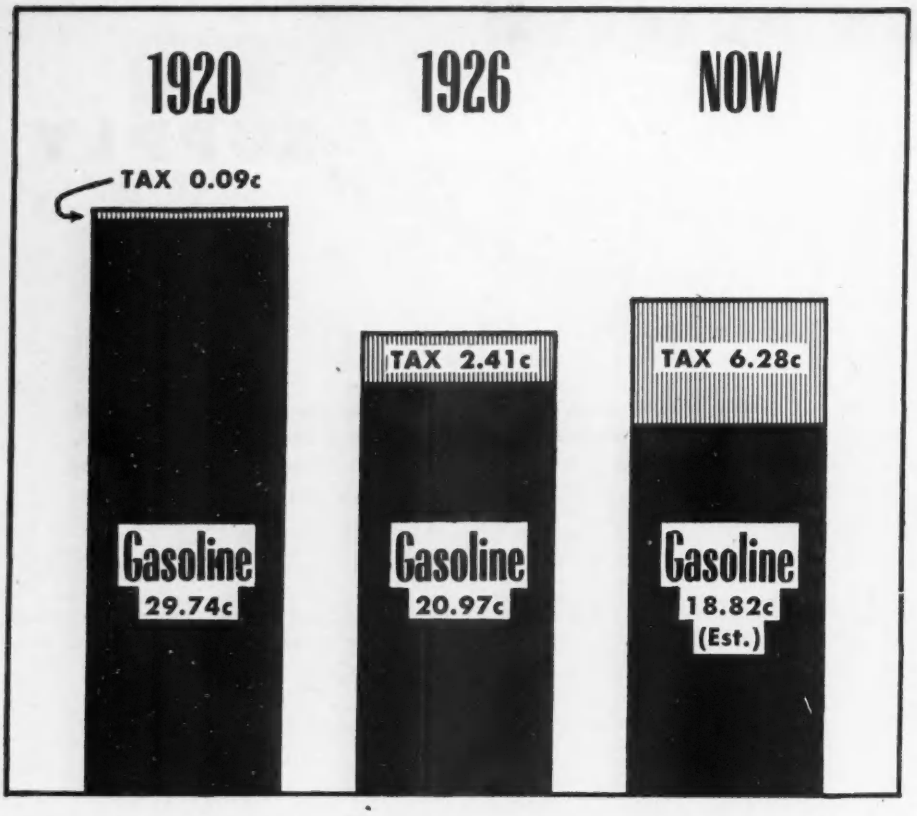


Including recent 50-cent raise, crude prices have increased less than other commodities.

Widely Assorted Opposition

So ended the hullabaloo that was touched off by Sun Oil Company's surprise crude raise, which was publicly opposed and temporarily but unsuccessfully resisted by some powerful competitors, besides being denounced by various politicians and labor leaders—a rare combination among the opposition. Oil company opposition was based on arguments that price increases should be avoided to stave off the evils of inflation; that higher prices could be justified only if they would bring forth increased production, which they actually could not do, it was claimed, because of steel and other shortages. Although unspoken, there also was fear in the industry that new price increases would invite ill will among the price sensitive public and encourage government control of the industry's prices and operations. Among politicians, the increases, as feared, actually did invoke denunciations of the industry and threats to bring about its regulation. An official of the Oil Workers' International Union, affiliate of the CIO, denounced increases in oil prices as inflationary, although the head of the oil workers union previously had said their union would follow the general CIO pattern of asking higher wages.

While all the opposition was being voiced, Sun Oil Company stuck to its higher crude postings and its original simple explanation that it had to post higher prices, as the only alternative to the unacceptable course of paying premiums, to prevent further loss of crude sources to competitors paying substantial premiums over officially posted prices. Subsequently, in response to criticism of the price increase, Sun's president, Robert G. Dunlop, ex-



Average service station price of gasoline plus tax. Following recent 1½-cent increases, the retail gasoline price, excluding tax, is still lower than in 1920 or 1926.

pressed hope that the increase would "eliminate the pernicious practice of premium payments," and challenged the argument that higher prices would not stimulate more production. "It is our belief," he said, "that an increased price will prove an incentive for stimulating increased production. Increased price always has had the effect of increasing production to some degree."

Many independent producers hailed Sun Oil Company as a champion of their interests, having the courage to do what it considered necessary, in spite of criticism that might be involved. A Tulsa stripper well operator, David A. Bartlett, president of Keener Oil and Gas Company, in a public statement emphatically disagreed with claims that a 50-cent price increase would not make more oil available. He said that if the raise stuck his company would cancel plans to abandon numerous stripper wells and said many other producers would do likewise. In addition, he said, the raise would make many high cost secondary recovery projects financially possible. Materials for secondary recovery projects in shallow fields are currently available, he added, as much light pipe salvaged from old wells cannot be used in present deep drilling. "The country should thank Sun Oil," he declared, "for adding these millions of barrels to our crude oil reserves."

Others who approved Sun's 50-cent price increase included Colonel Ernest O. Thompson, chairman of the Railroad Commission of Texas, who called the raise "the greatest incentive for discovering new oil fields since the end of the war." He further asserted, "Price is the greatest discoverer of oil and the greatest conservation agent. People do not waste that which is of value enough to conserve, and they search for new discoveries in proportion to price."

This was the second time within two months that powerful major companies had actively resisted higher crude prices, urging holding of the line on prices, only to see their objections overruled and their arguments cast aside by the rising tide of inflation. They deprecated the 20-cent increase initiated by Phillips Petroleum Company October 15, and deplored the new raise by Sun, but in each case were obliged eventually to meet the higher postings, regardless of what they thought of the soundness of the increases, economically, politically, or psychologically.

Out of this strained situation and disagreement over prices came, therefore, a reassertion of two great truths about the whole economic system as well as the oil industry. In the first place, the turn of events reasserted the elementary truth that under the competitive, free enterprise system, price ultimately has to be determined by conditions of supply and demand and cannot be "held in line" or otherwise artificially or arbitrarily determined. In the second place, the price developments reasserted the truth that in a competitive, free enterprise system, and in this case in the competitive oil industry, price actually is determined not by individual opinions or desires but by active competition and the impelling forces of supply and demand.

Oil Prices Lag

Although higher oil industry prices are no longer a matter for debate but an accomplished fact, the industry need not take a defensive position with regard to the now prevailing prices. Oil prices got where they are almost wholly because of forces and conditions beyond control of the industry. The remarkable thing about oil prices is that they are not even higher, considering the diluted buying power of the dollar and the sharper increases registered by commodities in general and various important commodities in particular. All commodities in the aggregate were in early December a little over 60 percent above the average 1926 level and raw materials were 77 percent above 1926, while the average price of crude oil, including the 50-cent increase ($2.62 per barrel), was only 39 percent above the 1926 level ($1.88 per barrel). Thus crude oil was still more moderately priced than other materials, as compared with the relationship in 1926, the normal year used as a base in the Bureau of Labor Statistics wholesale commodity price index.

Commodity prices in the aggregate were in early December within a few points of the peak reached after World War I in 1920, but crude oil at a new average price of approximately $2.62 per barrel was considerably under the 1920 average of $3.07 per barrel. In contrast with retail prices of foods and many other goods which have skyrocketed, retail prices of gasoline have increased quite moderately. Whereas the service station price of gasoline, excluding tax, averaged 29.74 cents per gallon in 1920, it was in December, 1947, following the latest 1½-cent a gallon increase, only about 18.82 cents a gallon, excluding tax. This was almost 11 cents below the 1920 price and it was more than 2 cents below the 1926 average price of 20.97 cents a gallon, excluding tax. These are highly significant figures, reflecting quite moderate present prices of gasoline as compared with those in the 1920's, though the industry does not get due credit for them when comparisons are made on the basis of prices including tax. Taxes on gasoline now average 6.28 cents a gallon, against 2.41 cents in 1926 and 0.09 cents a gallon in 1920. Even including tax, which is much greater now than formerly, the service station price of gasoline is nearly as low as in 1926 and about 5 cents a gallon lower than in 1920.

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12. Oil retainer ring insures constant oilbath lubrication of top radial bearing.
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14. Radial bearing, with renewable inner and outer races, placed low in the housing provides maximum steadying effect.
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STATES MUST CORRECT OIL LAWS TO ASSURE Maximum Recovery

By HIRAM M. DOW
Chairman, Interstate Oil Compact Commission

ALTHOUGH much progress has been made in oil and gas conservation, there is much to be done in the matter of conserving gas produced with oil. In terms of ultimate importance, the gas reserves of the country are more than equivalent to the oil reserves, and their conservation is equally important.

Gas conservation really involves two problems: (1) conservation of that gas which exists underground in gas reservoirs and is produced as gas through gas wells; and (2) conservation of gas produced with oil through oil wells. This gas usually is called casinghead gas to distinguish it from gas well gas.

Most states now have effective legislation prohibiting the flaring and waste of casinghead gas. Gas wells are kept closed unless the gas can be marketed for beneficial uses. Such compulsory closing of gas wells in the absence of markets has worked hardships in many cases. Within the past decade the process known as cycling has given a great boost to conservation of gas. Cooperation among producers and royalty owners for conservation has probably reached its ultimate in cycling operations. The nature of this process is such that a whole gas reservoir usually must be operated as a unit for efficient recovery of liquids. Statutes specifically authorize agreements to accomplish these objectives upon approval by some state official.

Casinghead gas is more difficult to conserve than gas well gas because it cannot be held back for market without disrupting oil production. In spite of this difficulty, great strides have been made. The orderly development and production of oil fields, with resultant long life at stable rates of production, make it possible to put long-term investments in plants for recovery of natural gasoline from casinghead gas and some marketing of such gas in competition with gas well gas. Many oil fields have casinghead-gasoline plants where under the old system of feverish competitive development a large part of the gas could not have been stripped because of prohibitive cost of facilities for very short-period peak production.

The greatest needs for further advances in conservation of casinghead gas are (1) laws permitting cooperative development and operation of oil reservoirs so the produced gas may be returned to the ground where its use in such fashion will increase oil recovery; (2) an improved price at the well head which will aid particularly in securing markets for oil field gas that must be produced for delivery to the transmission lines; and (3) adequate markets for gas.

Major Deterrent

One of the most serious deterrents to the conservation of oil field gas is the effect of the federal natural gas act as now construed by the courts, under which the Federal Power Commission is empowered to fix the price of gas at the well in the hands of the producer who sells for delivery into an interstate gas line.

A primary hope for conserving the great volume of oil field gas produced is for it to have a market outlet through the interstate lines to the industrial areas where gas is needed. When the natural gas act was enacted it was understood by the industry, by the Federal Power Commission, and by those sponsoring the legislation before the Senate committee that the act was to regulate the interstate transportation of gas and the sale at wholesale in interstate commerce after interstate transportation. It was not intended to cover the original sale by the producer or gatherer, or the ultimate sale to the consumer by the local distributor. These were matters of local state concern. The Federal Power Commission under the act is allowing a 6½ percent return to natural gas companies and takes into account all sources of revenue. If the producer is held to be a natural gas company and his sale of gas at the well is subject to price regulation and a 6½ percent return on his investment, it could well be that the producer would have to give away his gas because of returns from oil production. As a result of this situation the producer will be afraid to connect with an interstate line and therefore the flare gas from oil fields will not be conserved.

There is no more reason for controlling the price of gas in the hands of the producer than the price of any other commodity, such as oil at the well, coal in the mine, or corn or wheat in the field. The production and initial sale of gas are not public utility functions. Effective conservation of flare gas cannot be accomplished until this question is resolved either by a Supreme Court decision construing the natural gas act as prohibiting any interference by the Federal Power Commission with the production or gathering of gas or the initial sale by the producer or gatherer, or by a congressional amendment to the act to the same effect.

"Why," the public may ask, "would any operator hesitate to enter into a cycling program for a gas field or a pressure maintenance or secondary recovery program for an oil field if such programs are engineeringly sound, economically feasible, and will increase greatly the ultimate recovery of oil and gas?"

The answer is that the oil and gas producing states *must first enact laws* that will permit cycling operations, pressure maintenance, and secondary recovery programs, and they cannot be put into operation in gas or oil fields unless such fields are pooled or unitized; and this must be sanctioned by law in order to protect operators from anti-trust laws. Some of the oil-producing states have not yet enacted such laws.

It is imperative that the nation's reserves of oil and gas be maintained, especially in view of present unrest in the world. This is a hard problem, considering the fact that present reserves are being produced at all-time record rates. The discovery of new reserves is an increasingly difficult problem. Consequently, our known reserves must be developed to the maximum. Toward this end, the people of the nation, the states, and the members of Congress should lend every encouragement.

We cannot in good conscience fail in our efforts to correct those conditions which may prevent the greatest ultimate recovery from our known reserves of oil and gas. Each state must now do its part to the utmost in bringing about the correction of any deficiency in state law which prevents the application of production methods designed to recover the maximum of its oil reserves. Each and every state owes this to itself and to the nation.

From an address before annual meeting of API, Chicago, November 13, 1947, entitled, "The Conservation of Oil and Gas."

By GILBERT M. WILSON
Staff Writer

DEMAND MAY FORCE California Imports BY 1950

A 50 PERCENT plus increase in demand since 1940 has been matched by a step-up in California production. But fields have been produced in excess of efficient rates, and proved acreage has been largely drilled up. Exploration for new reserves has been fairly successful, but in absence of unforeseen discoveries of highest class, the state will have to turn within a few years to outside sources for supplemental supplies.

COUNTING demand coupled with a declining rate of new discoveries of major importance probably will force California to import crude oil sometime in the early 1950's. When this happens, and it seems inevitable unless presently unforeseen fields of the magnitude of Wilmington or Kettleman Hills are discovered, the state will have to turn to outside sources in order to keep supply in balance with demand.

No shortage of oil is foreseen in the Pacific Coast for the next year or two, and in fact consumers in the area may never have to curtail consumption during peacetime. Inability of the state's productive capacity to keep up with demand would mean simply that supplies would have to be augmented with crude from other sources. Possible sources of supplemental crude include West Texas-New Mexico, the Rocky Mountain region, Venezuela and the Caribbean sources, and the Middle East.

Reduced to its simplest terms, the situation in California is this: Total daily demand for California products has increased from slightly over 600,000 barrels in 1940 to nearly 927,000 barrels in December, 1947, an increase of more than 50 percent. Since the end of the war, production has just about kept pace with demand. However, this has been at the expense of considerably exceeding the maximum efficient rate of production recommended by the California Conservation Committee; by reduction of exports from a 1940 rate of 170,000 barrels daily to a present rate of about 80,000; and by the drilling up of known productive areas proved during and since the war.

New reserves, which include new field discoveries, extensions and revisions, which had been keeping pace with increased consumption have been fluctuating over narrow margins for the past several years, either slightly above or below the rate of withdrawal. In 1946, total new reserves added fell short of actual production by approximately 75 million barrels. The outlook for 1947, although final figures are not yet available, shows a probable total withdrawal of approximately 333 million barrels, a figure which will just about offset new revisions, extensions and discoveries developed during the year.

Peak Production in 1948

Authorities estimate that California production will continue to climb, approaching a maximum of about 950,000 barrels daily some time in early 1948, after which it will start to decline. Unless major discoveries are found shortly, such a peak is inevitable inasmuch as the backlog of undrilled locations is being drilled up at a rate faster than new locations are being found. Assuming the discovery rate to continue on about the same level as in recent years, it is probable that the state will have to import an estimated 6000 barrels per day by 1950, 64,000 by 1951, and 105,000 by 1952. These figures are based on an estimate presented in a paper by R. E. Minckler[1] before a recent meeting of the AIME in Los Angeles.

It is estimated that the future production rate may drop to around 750,000 barrels per day by the end of 1952. This estimate is based on the normal decline of known fields, new production from new wells to be drilled in known productive areas, plus a "speculative" production from future discoveries. The curves in Figure 1 graphically illustrate these probable future trends. Some engineers and persons close to the supply-demand picture may differ slightly with the actual time of the critical point at which production will begin to turn downward. One authority believes it might not occur until closer to 1950, but the general trend remains the same in that imports in the order of perhaps 100,000 barrels per day may have to be obtained sometime between 1950 and 1955.

Why has this looming scarcity of production become apparent only recently? The answer lies in a number of things which have greatly altered California's economy during the past six or seven years. The greatest single factor probably is the state's phenomenal increase in population.

Over the past seven years, population of the Pacific Coast states has increased from 10.4 million in 1940 to 14.5 million in 1947, an increase of about 39 percent. California's population alone increased 43 percent. These increases are to be contrasted with an annual normal rate of increase of about 1 percent, compounded. For the nation, this same period showed a population increase of slightly under 9 percent. This great increase in population in the western states alone would have accounted for a substantial increase in consumption of petroleum products. However, statistics reveal that during this same period, total consumption of energy increased by about 72 percent, representing a per capita increase of unusual proportions. The term energy in this case is the common denominator to which all sources of energy, petroleum, hydroelectric power and coal and wood are reduced for the purpose of drawing

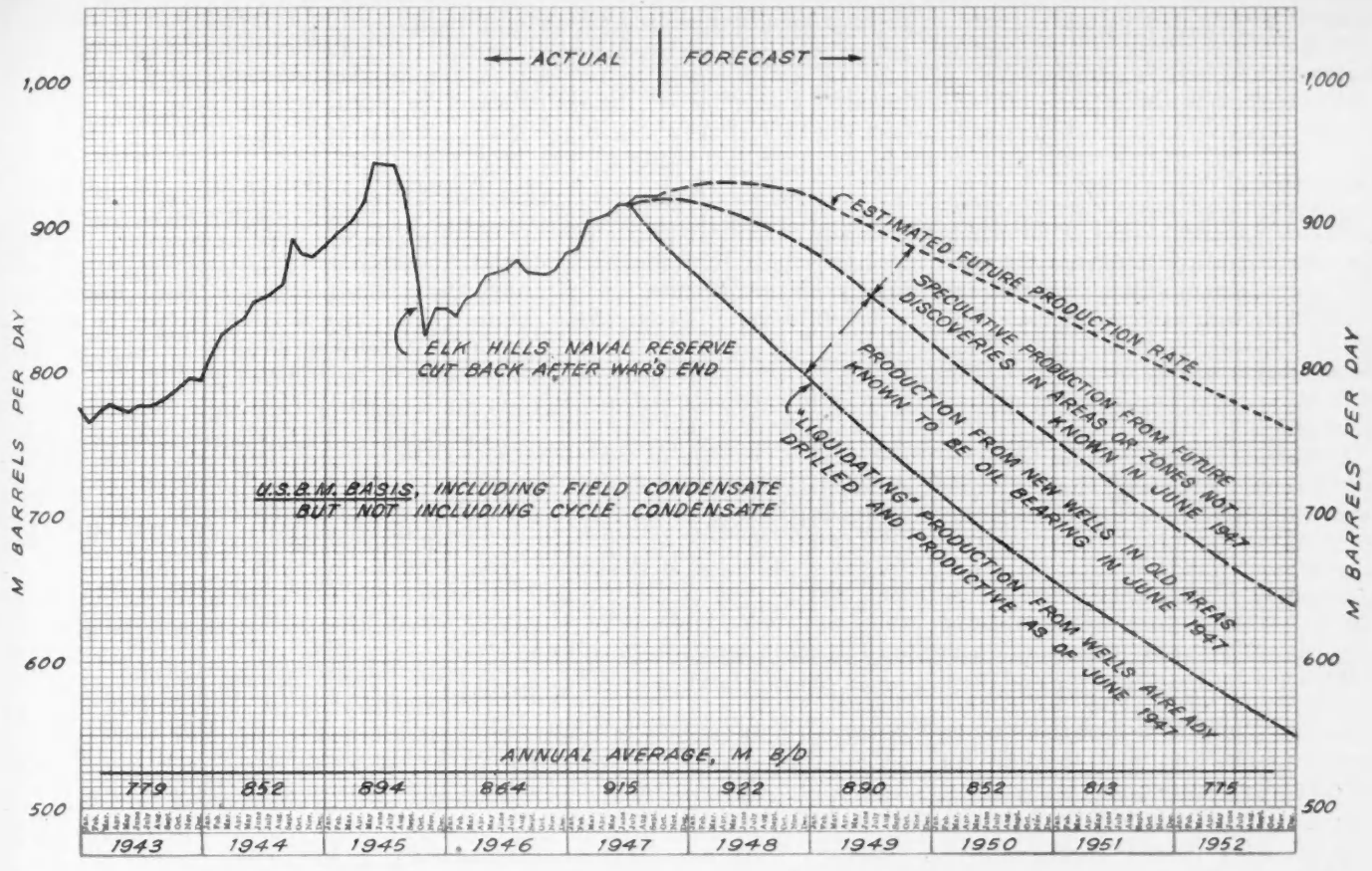

FIGURE 1. Estimated future production rate of existing wells, production from new wells in old areas, and speculative production from future discoveries were plotted together by Minckler[1] in order to arrive at the approximate daily productive capacity of California over the next five years.
Courtesy General Petroleum Corporation.

comparisons. Over 90 percent of the total energy produced was supplied by oil and gas, which is a fair indication of the extent to which the state's economy is dependent on petroleum products.

In 1946, total demand for all petroleum products, including offshore shipments averaging 59,000 barrels daily, amounted to 898,000 barrels per day. For 1947, total demand is estimated to be approximately 1 million barrels. Minckler[1] estimates that demand in 1948 will be slightly higher than that for 1947, but thereafter will taper off, reaching an average rate of about 950,000 barrels daily in 1950-52.

A striking example of how the consumption of fuel has increased is seen in the state's electric power generating plants. Before the war these plants used between 6000 and 8000 barrels of fuel oil per day, but in 1947 they were consuming fuel at a rate of 45,000 barrels per day. New steam plants are being installed and it is believed that this type of demand will remain high for years to come, fluctuating perhaps as periodic wet and dry years affect water storage in hydroelectric storage dams.

A motoring-minded public has increased its gasoline consumption by well over 50 percent. Home fuel oil installations have increased from 230,000 burners in the latter part of 1945 to about 365,000, and they are continuing to increase. Stepping up of industrialization, including the numerous plants and factories coming in from other states, contributes much to the increasing demand.

Under the impact of increasing demand, the state has been exceeding its maximum efficient rate of production since the latter part of 1945 following the general cutting back of production and the Navy's shutting in of most of its Elk Hills production after V-J Day. As brought out by Wm. R. Wardner, Jr.,[2] the spread between the MER and actual production has been on the increase since that time, and at this writing amounts to approximately 68,000 barrels per day (Figure 2). Viewed in relation to the overall daily production of the state, this overage might not appear to be very serious. However, it must be realized that this over-production comes out of perhaps a little over half of the state's total production. About 400,000 barrels of the state's daily capacity comes from pools that are on the unscheduled list; that is, those which already are producing at or near their maximum capacity.

What the net effect this overproduction will have on flush pools is difficult to estimate. In the sand reservoirs of California it is possible that most of the recoverable oil ultimately will be obtained from an over-produced pool, but at the expense of an earlier resort to artificial lift and a consequently longer period to recover it.

The California production outlook, also contains some facts on the credit side of the picture.

First of all, it should be noted that California reserves have maintained a nearly constant figure of slightly over 3 billion barrels, and have even increased somewhat during the past ten years. This in spite of the fact that about 2.7 billion barrels were actually produced during the same period, which included the war years and the still record-breaking peacetime demand since V-J Day. This takes into consideration also that normal decline of existing fields was taking place. Proved reserves in December 1937 amounted to slightly over 3 billion barrels, whereas in January, 1947, reserves were in the order of 3.3 billion barrels (Figure 3). Total petroleum stocks in the Pacific Coast territory presently amount to slightly over 90 million barels, representing a supply backlog of approximately 94 days. This is only slightly below the recommended economic working level of 100 days' supply and is not considered serious inasmuch as seasonal demands frequently cause considerable fluctuation. The historical record of California stocks and average daily production and

demand is shown in Figure 4.

It has been estimated that to sustain California's production at the level of demand and at the MER, new discoveries equivalent to the productive capacity of the Wilmington field would have to be found each year. However, it cannot be assumed that further discoveries of major importance will not be found. Despite scarcities of sorely needed tubular goods, there is an increased possibility that, with a more favorable "climate" of increased crude prices, additional capital will become available for drilling in areas previously considered a poor risk.

With evident alarm, some point to the fact that California, over the past five to ten years, has found only fields of comparatively small size. It must be remembered that over this same ten-year period, which included World War II, it was this group of small fields, plus extensions and revisions, which maintained the state's reserves at their present figure. Marion Dice[3] has pointed out that if discoveries continue to be made at a rate equal to 10 to 15 percent of current production, and if these discoveries are followed by a normal expectation of extensions and revisions, reserves will continue to be kept in balance. Extensions to known fields normally yield about six additional barrels for every first-year discovery barrel.

Developments during the past 12 to 18 months hold promise of turning up further reserves of importance. High-gravity oil production in the Montalvo area of Ventura County; the Four Deer, multi-zone area in Santa Barbara County; and the prospect of Eocene production in Middle Dome of the Kettleman Hills area, are among brighter spots now undergoing development. Along the west side of San Joaquin Valley a number of small fields and extensions, some having several zones, are being uncovered in spite of the fact that they are located in or near old and well-developed fields.

In a paper presented at a recent meeting of the American Association of Petroleum Geologists, Graham Moody[4] summarized the results of exploratory drilling in the state over recent years. Annual exploratory drilling footage has increased from 539,000 feet in 1940 to a yearly average of about 1,600,000 feet during the 1945-1946 period (Table 1). The same data indicate that success percentage, which in 1940 was 9.6, averaged about twice that amount, or 18-19 percent, in 1945-46, although during the war it reached a peak of 25 percent during one year. With exploratory drilling progressing at such a high rate, and with the success percentage double the prewar rate, the odds are not too severe that substantial reserves may yet be found.

Secondary recovery holds promise of further bolstering the state's productive capacity, but results to date, while generally satisfactory, have been incomplete, and not on a scale which would materially affect the production outlook between now and the critical period of the early 1950's. In fact some authorities believe that secondary recovery on a large scale still is some five to ten years away. Because of the success of secondary recovery practices, notably water flooding, in other parts of the United States, considerable thinking has been spurred along those lines in Cali-

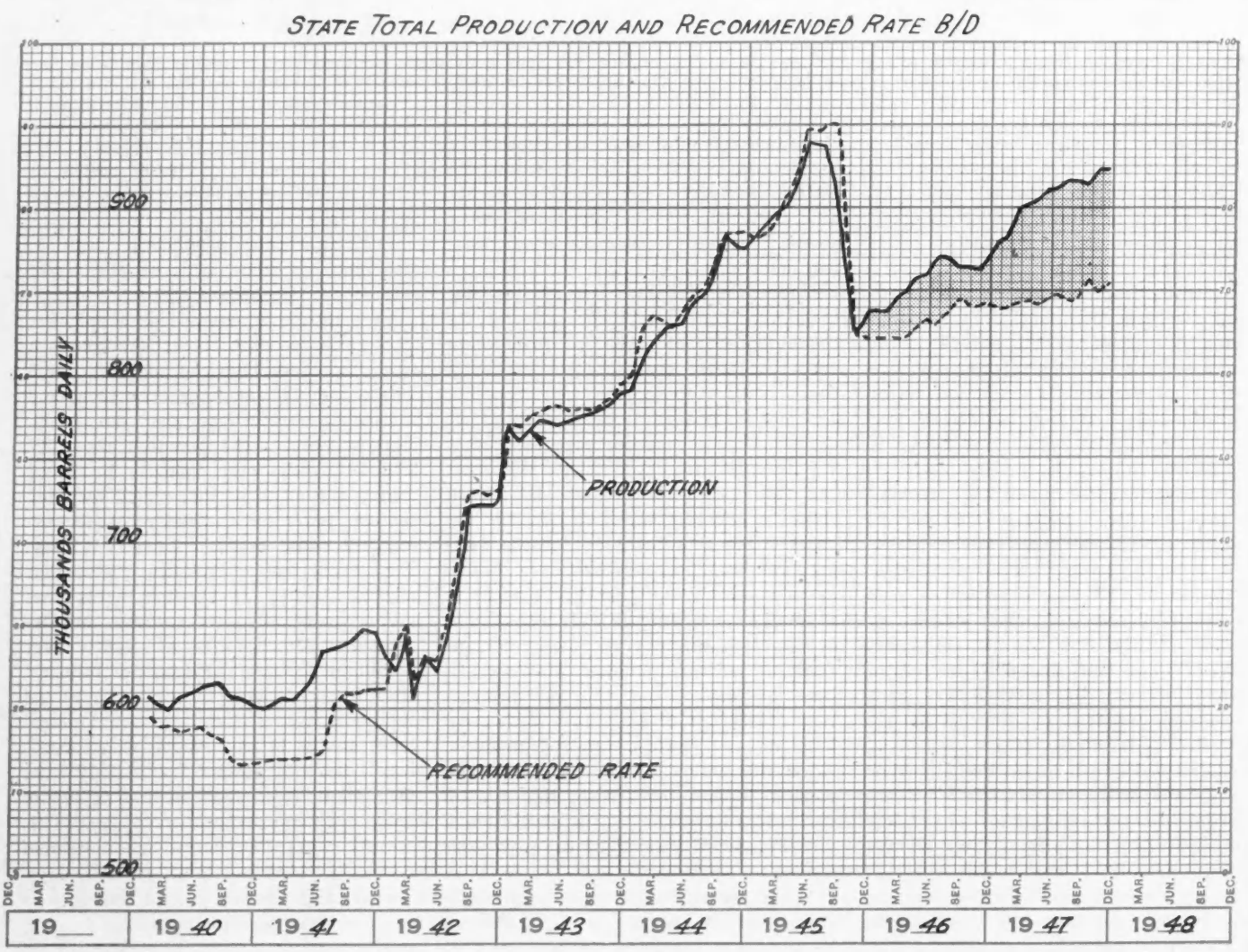

FIGURE 2. Shaded area between the two curves in this Conservation Committee chart illustrates the extent to which California's daily production rate has exceeded the recommended maximum efficient rate of production since the production cutback following V-J Day.

fornia. Water-flood operations are in progress in at least two California fields.

With an estimated 60 to 70 percent of the original oil still remaining in the formation, and with oil sands from 100 to 1000 feet in thickness, many of the old fields present a wide-open opportunity for new ideas in secondary recovery techniques which could be applied to these potentially great reserves. In addition to the two water-flood projects, there are two cycling projects and 12 to 14 other pressure maintenance projects in the state.

Considerable discussion has been stimulated by the expressions of some engineers that it might be preferable, from the standpoint of ultimate recovery vs. high costs of plants and losses sustained in cycling or pressuring operations, to produce a field along the normal decline curve to depletion, after which secondary recovery methods then could be instituted. In support of these newer ideas was the discovery of one major company that out of a group of 20 projects in the U. S., only five pools reacted to pressure maintenance to a degree that promised a higher ultimate recovery than would have been obtained had they not been produced to depletion in conventional manner.

Another major source of crude, and which only recently has come to the forefront as a possible major source of the new reserves, is the numerous known deposits of very heavy oil. Passed over until recently as being uneconomical to develop, and with prices in those gravity ranges then being less than one third what they are now, these deposits hold promise of augmenting supplies of heavy fuel oil. Largest known deposits in the state are located principally in coastal counties and in many localities in the San Joaquin Valley. Advanced techniques involving the use of distillate injected into the well and hot water circulating systems inside the casing or tubing are among the methods presently being employed to produce the oil. In one coastal field, oil of six-degree gravity is being pumped successfully.

For various reasons California cannot look with much hope on the possibility of extracting synthetic fuels from natural gas, coal or shale. Gas already is in tight supply for fuel purposes. There are no known coal deposits of sufficient size to warrant consideration as a source of synthetic fuel. Oil shale, only now being handled experimentally at Rifle, Colo., is not considered as a possible source of oil for California.

Other factors tend to alter the present outlook for the California oil industry. Exports, which before the war amounted to 170,000 barrels per day, are now down to about 70,000 barrels per day and are expected to gradually dwindle to perhaps 25,000 barrels daily by 1952. As soon as production facilities in the Netherlands East Indies are rehabilitated, that area will supply crude to markets now being supplied by some of California's offshore shipments. By 1952 it is expected that Canada will be the only major market for California crude. Canada, however, is making progress toward eventual self-support. Several recent discoveries in the Alberta Plains country have gone far toward establishing reserves of major importance, as for example, the Leduc field, which since its discovery early in 1947 already has a proved reserve of upward of 100 million barrels of high-gravity oil.

Natural gas from the West Texas-New Mexico area, brought to California through the recently completed 30-inch high pressure line, is expected to have an effect on the fuel market on the Coast. Initial capacity of the line will replace an estimated 31,000 barrels per day of fuel oil, and when operating to capacity, will replace about twice that amount.

Texas Possible Crude Source

The thought has been expressed that for once in a longer period than most oil men like to think about, California is experiencing what is considered to be a normal economic condition in which supply is about equal to demand, and in which there is no surplus. However acceptable that situation might be, and despite prospects that with continued discoveries the state's productive capacity may be sustained at or above the demand level for some years, tentative long-range plans for the importation of crude if and when needed.

The Permian Basin area of West Texas-New Mexico, probably one of the largest sources of reserves still remaining in the U. S., has been talked of as a logical and possibly cheapest source of crude. It has been argued that a pipe line tapping that region could parallel the new 30-inch gas line and thus cut to a minimum the effort and cost of such a line. Some questions have been raised, however, as to whether the area will have an exportable surplus in view of recent heavy demands on the area for shipment to eastern points. A significant move recently made by the Texas Railroad Commission was the abolition of shutdown days in the area for the first time in eight years, indicating the extent to which the area is being called upon for greater output.

What the supply situation there might be in several years is just as doubtful as the pipe supply situation might be at the same time. Cutbacks in supply of steel occasioned by requirements of the Marshall Plan may advance pile line plans still further into the future. Early in 1947 a group of major companies drew up tentative plans for a 20-inch, 150,000-barrel per day capacity crude line to run from Midland, Texas, to Wilmington, Calif. The plans were shelved when it developed that pipe would not be available for at least several years. At that time it was estimated that oil could be moved to California for about 25 cents per barrel.

Another important consideration is the matter of crude oil price postings in effect in Texas and California for crudes of comparable quality at the time a line might be contemplated. If, for example, West Texas crude was bringing about the same price as the same gravity California crude, and it became necessary to offer a higher price to cause the Texas producer to break his connections with already established markets, that cost, plus the transportation cost, would lay the imported crude down in California at a substantially higher price than the going California prices. Such a situation might have the effect of boosting crude prices both in West Texas and California. If sour crudes were brought in, the added cost of refining these products would also have a bearing on the ultimate product cost to the California consumer.

The situation in the Rocky Mountain region offers little encouragement for possibly importing crude from that area unless, as in the case of West Texas, there happened to be an excess of crude available at about the same time California found it necessary to import supplies. One factor in California's favor, however, is that several large California companies are operating in the area, and should they develop large supplies of crude and their refineries

TABLE 1

Results of exploratory drilling over past seven years as summarized by Moody.[4] While success percentages are dropping off slightly, they still are twice that of the prewar (1940) rate, giving rise to the belief that with a sustained high rate of drilling, additional reserves of importance still may be found.

YEAR	1940	1941	1942	1943	1944	1945	1946
No. Expl. Wells Drilled	104	124	163	251	315	411	366
Success Percentage	7.7	12.9	11.7	22.7	22.5	20.9	19.1
Total Footage Drilled (Feet)	539,289	640,470	817,060	1,064,088	1,437,501	1,776,468	1,584,647
Success Percentage	9.6	13.6	16.8	25.0	24.9	17.5	19.4
Reserves Added per Foot Exploratory Hole (Barrels)	422.63	91.73	79.49	110.83	162.47	125.35	83.40

and domestic distribution systems in California require the crude, there then would be a greater possibility of their constructing a pipe line to bring crude into San Francisco, Los Angeles or even points in the northwest.

Rumors have been circulated to the effect that a pipe line might be built between Colorado's Rangely field and some point on the coast. Adding impetus to the belief is the recent scheduling of a ten-inch crude line to take crude from that field to Salt Lake City, where a 25,000-barrel capacity refinery is to be constructed. Whether that line might be extended to the Coast is problematical. A glance at the current Rocky Mountain supply-demand picture would tend to discourage optimistic beliefs that sufficient crude was available for California needs.

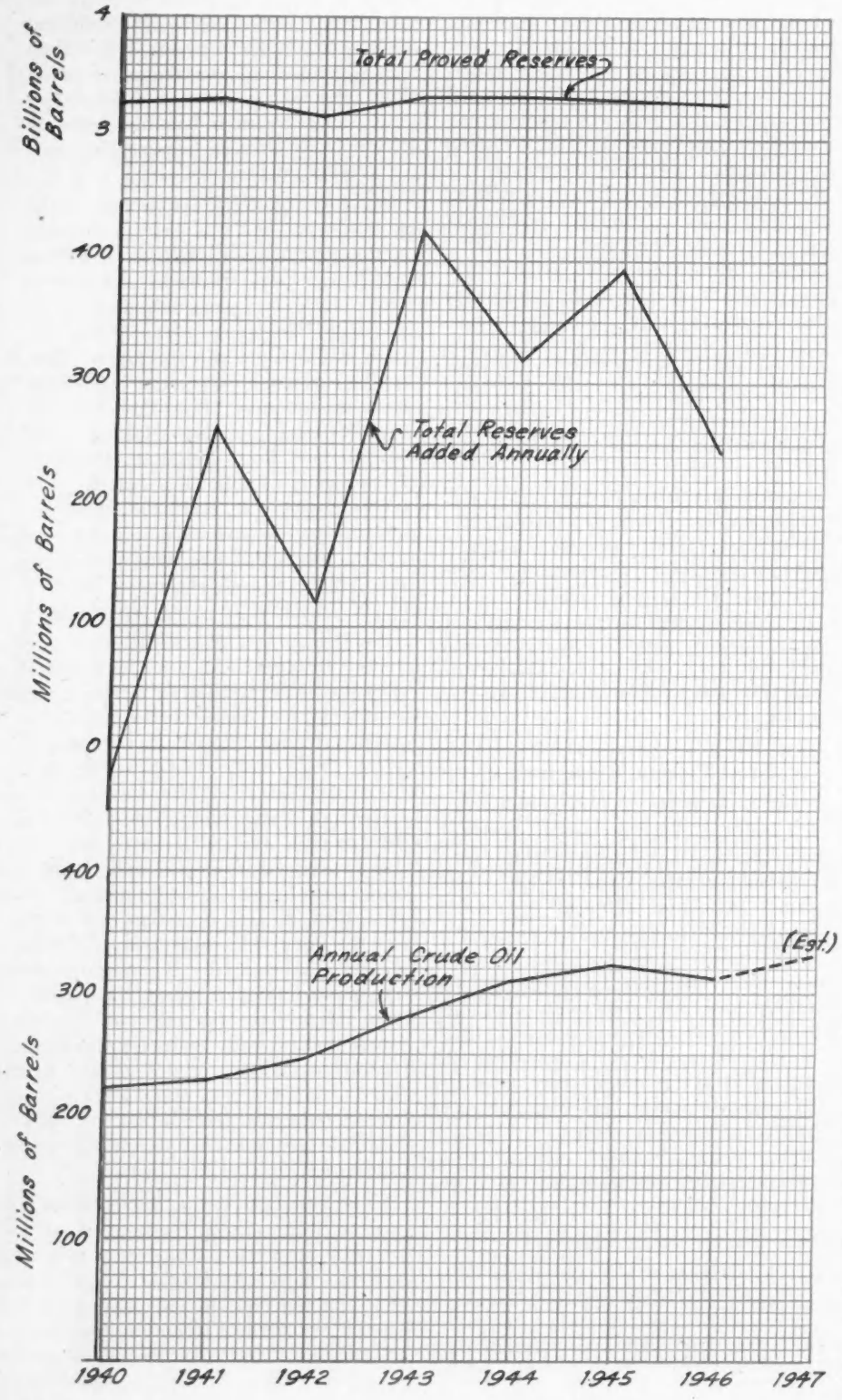

FIGURE 3. Curves showing, for the past seven years, the status of California's reserves, rates at which new reserves have been added annually, and the annual rate of crude oil production. Reserves position has remained nearly constant despite a withdrawal of about 2.7 billion barrels over the past ten years.

Present daily production rate of Montana is about 26,000 barrels; Wyoming, 110,000 barrels; and Colorado, 49,000 barrels; making a total for these three principal producing states in the region about 185,000 barrels per day. While it is probable that these production figures will rise as aggressive wildcatting continues, the demand in the area also is on the increase. Daily demand in the area in August, for example, was approximately 200,000 barrels. Montana's crude yield still is far below the state's refining capacity, and imports from Wyoming and Colorado have had to be resorted to. If, as it is estimated, California's production will fall short of demand by 105,000 barrels per day by 1952, it seems at this time that Rocky Mountain states would be able to satisfy but a fraction of this amount, if any at all. These assumptions are made, of course, on the present outlook for the region. The possibility should not be ruled out that, spurred by higher crude prices and possibility of a ready market outside the area, an energetic drilling campaign might uncover a number of fields of the size of Rangely, and thus develop an exportable surplus.

Arabian Imports

The Middle East, where reserves are estimated in terms of billions of barrels, offers the next plausible source of crude. Cost of transporting from that area, whether to unload on the east or west coast of the U. S., and ultimate cost of crude laid down in California are considerations being weighed. Many factors enter into the problem of determining cost of tankering crude from Middle East ports to California. Import duties, canal fees, rates for chartered ships which vary according to size and speed and whether operated by American or foreign crews, are but a few of the variables involved. Adjustment in rates which would come about with increased competition as more shipping companies entered the picture as volume of imports increased, and tanker capacities which presently average between 80,000 and 100,000 barrels but which soon may be designed for 200,000 barrels, present other facets which would affect ultimate price to the California consumer. What Middle East oil would cost per barrel laid down at Los Angeles Harbor, depends on the foregoing factors. However, some estimates have been made by oil industry authorities, and a figure considered as a "starting point" in the calculations or estimates is about $2.75 per barrel.

It is the belief of some industry spokesmen, however, that it will not

be necessary or advisable to bring Middle East crude to the West Coast. A more likely solution from the standpoint of shipping costs appears to be to unload it on the East Coast where a ready market awaits it and where refining capacity is available. This would have the effect of backing up oil which now is being moved eastward through pipe lines and coastal tankering from already hard-pressed Mid-Continent areas, as well as some of the crude being shipped from Venezuela. With the Mid-Continent area then consuming more of its own oil, California could obtain crude from Venezuela to supplement its production, and probably at a lower cost per barrel for shipping.

Effect on California Prices

The question naturally arises as to what effect imported crude, from whatever source, would have on the price of domestic production in California. It is the belief of several industry spokesmen that rather than becoming a depressing factor, the imported crude instead would tend merely to put a ceiling on the domestic price level. Except for certain crudes which might demand a premium due to more desirable refining qualities, the price of imported crude laid down at local ports would in general determine the approximate price for comparable California crudes.

A question that might seriously affect long range planning of secondary recovery programs in the state also hinges on the crude price situation. Assuming that ample foreign oil could be brought into the state for, say, $2.75 per barrel, and further assuming that domestic crude prices might closely approach that figure within a few years, would the narrowing margin between imported price "ceiling" and the going price for domestic primary production tend to retard or discourage long range planning for the more costly secondary recovery projects? The answer to this and related questions may lie in whether it will be possible to rely heavily on foreign sources, the international situation being what it is today.

Prices for finished products affects still another phase of the California supply picture. For some time the lower selling prices of certain products, such as bunker fuel and railroad fuel, has encouraged higher bidding by eastern buyers, the margin being sufficient to permit transporting the oil to eastern markets. At the present time, for example, bunker fuel at Los Angeles Harbor sells for around $1.75 per barrel, which is approximately $1 below the New York price. This differential has encouraged many shipping lines to fill their bunkers on the West Coast whenever possible. With higher crude prices and probably higher product prices which many feel are imminent, some of these differentials may be eliminated, forcing outside buyers to other markets. This would encourage the shifting of refinery yields to those products needed in the expanding domestic market of the western states.

However disquieting the outlook may be today on the California oil industry's ultimate ability of remaining self-sustaining, there is ample justification for encouragement to be found in the intense rate of exploration going on in the state and in the higher prices being offered for crude, which will prove to be an incentive for even more drilling. With greater sums being earmarked for research in efforts to increase both primary and secondary recovery, and with prospects for supplemental oil being available from any one of several sources if needed, the California population, however large, may not have to worry about its peacetime petroleum needs.

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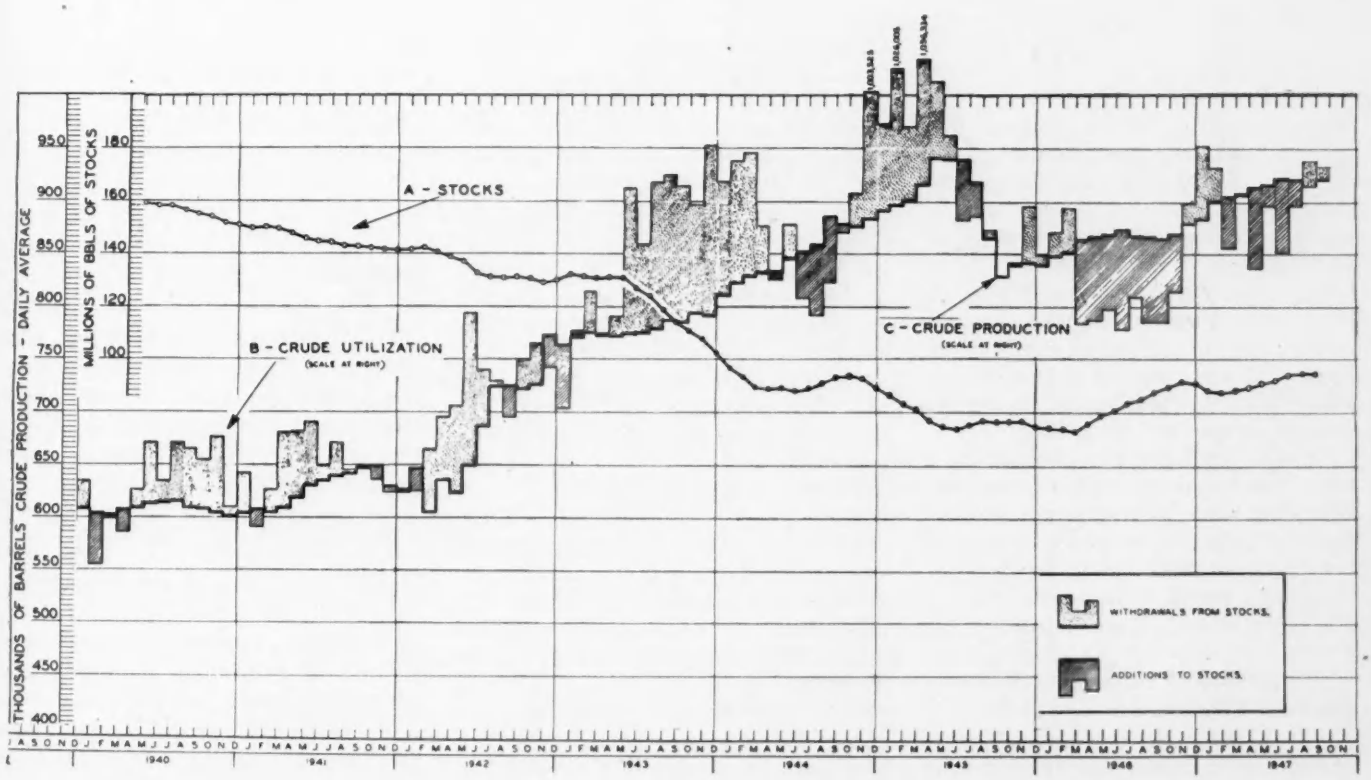
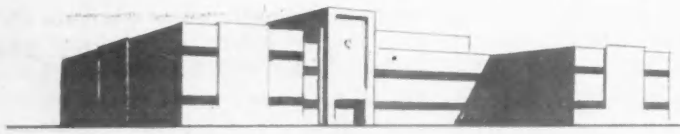


FIGURE 4. Graphic historical record of California oil industry since 1940. Shaded areas above or below production line indicate withdrawals or additions to stocks from month to month. Present stocks are only slightly below the recommended economic working level of 100 days supply.

PRODUCTION—EXPLORATION

RESEARCH EXPANDING



DEDICATION of the $1,600,000 Shell Oil Company production research laboratory at Houston early in December highlights an important trend throughout the U. S.

Prior to a few years ago, the research laboratories of large oil companies were largely concerned with refining. But during recent years such companies as Phillips Petroleum Company, Standard Oil Company (Indiana), Humble Oil & Refining Company, The Carter Oil Company and others, have entered the exploration-production research realm in a substantial manner. They have made considerable investments in laboratory equipment and payroll, although Shell's new effort involves perhaps the largest expenditure for laboratory and equipment yet announced.

These research laboratories consolidate and concentrate oil industry efforts to develop better, more efficient, and more economical ways to find and produce oil, and are increasingly necessary in order that the industry can supply the constantly growing demand for petroleum products. Besides working on improvements in the present methods of looking for oil, the laboratories are persistently seeking entirely new ways of discovering oil. Other workers at the same time are devoting their time and efforts toward developing better ways of getting oil out of the ground.

Physics, geology, and chemistry are employed as research tools, working with and also independently of each other. Traditional research techniques are employed, but in addition, there are "no holds barred." Researchers are at liberty to develop and employ wholly new techniques.

The purpose of the new Shell laboratory at Houston was described by a company executive as twofold: (1) to develop more precise and reliable ways of finding new oil reserves, and (2) to develop more efficient means of recovering oil after it is found.

"With the increasing importance of oil in a mechanized world," declared H. S. M. Burns, of New York, Shell Oil Company president, "it has become of paramount importance to make certain that no source of energy is wasted. This fact is amply recognized by the state of Texas in its conservation laws. Means must be found for extracting the last possible barrel of oil from the existing oil fields and from those which will be discovered in the days to come. Much progress already has been made in this direction, but there is still plenty of room for a great deal of scientific work to improve present-day practices and to develop new methods."

Laboratory Arrangement

In Shell's new three-story laboratory building, designed for outward expansion to the rear, the physical and geological departments are located on the first floor. The chemistry and administration departments are on the second floor. Air-conditioning system and related equipment are in the penthouse on the third floor. Standard research units set up throughout the building consist of a large laboratory and two adjoining smaller rooms, each serviced with hot, cold, and distilled water, compressed air, steam, vacuum, and natural gas. Special research facilities include seismic instruments able to measure movements as small as the diameter of a water molecule, high pressure fluid flow equipment using scattered neutrons; apparatus for studying pressure-volume-temperature relationships of distillate well fluids, complete spectroscopic equipment, X-ray diffraction equipment, radar, polarigraph, specially built equipment to study well-logging instruments, and other special equipment to study fluid flow under pressures as high as 10,000 pounds per square inch and temperatures as high as 300° F.

In addition to the main laboratory facilities, facilities at the Shell plant include machine shops equipped with precision tools so the laboratory can build much of its research equipment; full photographic and other reproduction facilities; stenographic department; library with shelves for 10,000 volumes; conference room to seat 75, with built-in, sound-proof motion picture projection booth; cafeteria with outdoor terrace.

For outside research there will be a land experimental crew and a marine experimental crew equipped with three boats.

The staff of the new laboratory includes about 150 persons. Director is Dr. Harold Gershinowitz, formerly research director of the company's manufacturing department and prior to 1938 research associate at Harvard and Columbia universities. Associate director for exploration is Dr. M. King Hubbert, graduate of the University of Chicago and for ten years lecturer on geology and geophysics at Columbia University, during which time he also worked with the U. S. Geological Survey. Associate director for production is J. P. Murphy, graduate of the University of California, who previously held various production engineering positions with Shell in California. Laboratory manager is Dr. N. D. Smith, Jr., a graduate of University of Texas and a holder of a doctorate in physics from Harvard, who started with Shell as seismologist in 1935 and served during the war years with the Naval Ordnance Laboratory in Washington. In addition to the resident staff, which will be regularly increased during the next few years, outstanding professors have been retained on a consulting basis.

Moves by the major companies such as the establishment of this laboratory by Shell are of more than passing interest to the independent producer.

Major oil company efforts in the realm of refining research unquestionably have given to many of the majors decided advantages over the independent refiners. Such research efforts on the part of the majors in exploration and production affairs could easily give them a pronounced advantage in the production realm, even though the smaller company might be given the right to license the use of such discoveries as will be made.

In the past, due to the manner in which geophysical research has been carried on, the fruits of most of such research have been available on a consulting fee basis to independent and major alike, and as a matter of fact, the original efforts in geophysics in the U. S. were financed not by the top majors but by what might well be called "minor" or "independent" money.

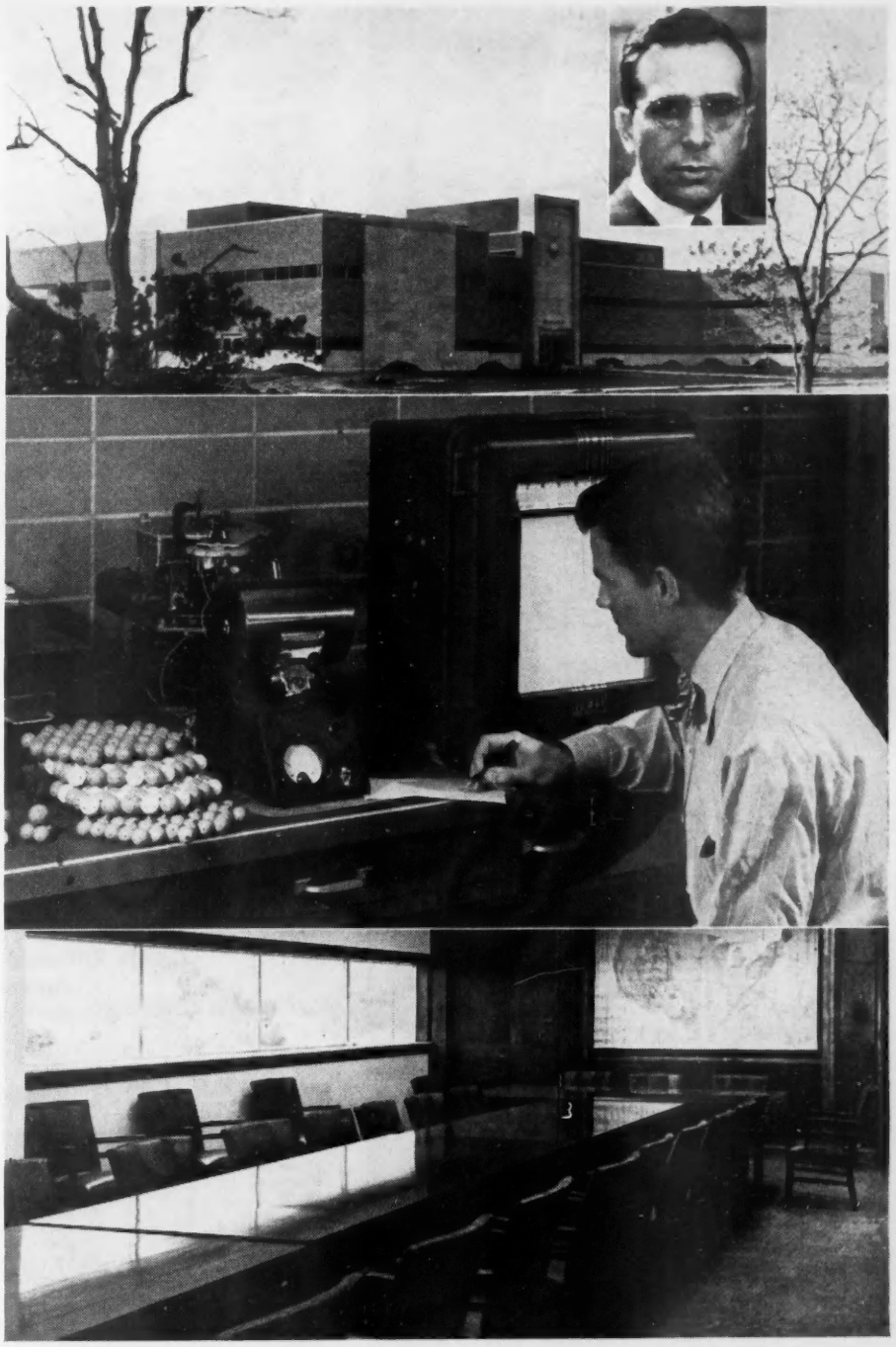
Of course, it would be a misstatement to infer that no independent money has gone into research. The American Association of Oil Well Drilling Contractors has raised, largely but not exclusively from among its own members, several hundred thousands of dollars to be spent in research on drill-stem corrosion.

Through the Pennsylvania Grade Crude Oil Association, independent producers of the Appalachian region have carried on research and development in secondary recovery, with the result that methods have been worked out whereby many millions of barrels of oil will be recovered from fields formerly considered as practically depleted. Many improvements, such as finding really successful plugging agents and the prevention of corrosion, permit wells to be operated economically longer, thus arresting decline and increasing ultimate recovery. The work by this association's research department and by independent producers in the region probably has amply paid for itself in recovered oil that otherwise would have been lost. Today, the producer is developing acreage in the district which a few years ago was considered worthless. More efficient methods and better operating practices have made this marginal area productive and profitable.

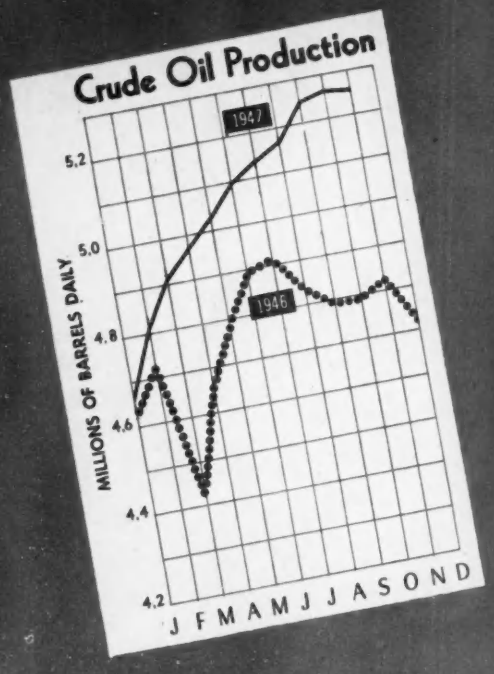
It is likely that there may be in the future substantial joint efforts on the part of smaller oil companies in research to keep them fully abreast of the times.

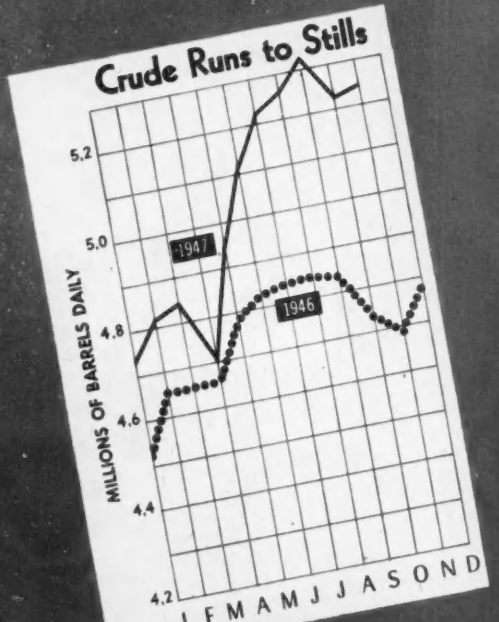
A venture now in the making which might well have great beneficial results to oil companies, little and big, is that sponsored by Thomas B. Slick, Jr., independent oil operator and holder of a degree in science from Yale. He founded two related research organizations at San Antonio. Chartered as non-profit, charitable undertakings, the projects were designed to become financially self-supporting after a development period from earnings through research fees and patent proceeds and from sales of blooded cattle from a ranch included in the project. The scope of the work undertaken by the Slick research organizations lies between the fields of pure scientific study, as carried out by universities and similar institutions, and the completely industrial research of limited range as conducted by industrial corporations. Slick has placed but one limitation on projects submitted for development: they must have a distinctly practical application.

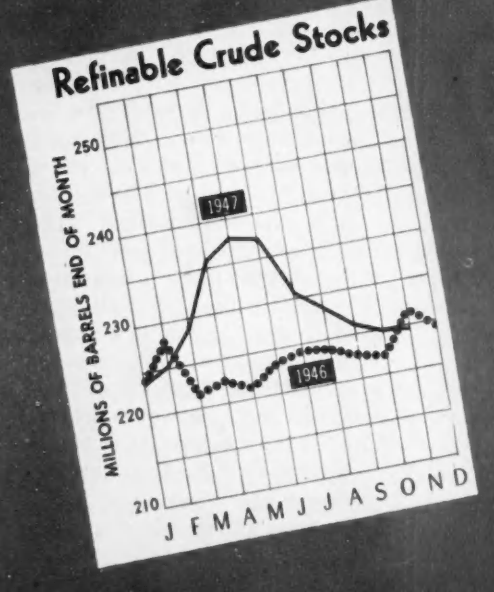
Besides processing inventions, the industrial research organization concerns itself chiefly with technical work for corporations, particularly in the field of petroleum engineering, although covering many other fields as well. This work is conducted on a basis similar to that in use at Armour, Midwest, and Mellon Institutes. Of an inventive turn of mind, Slick himself has submitted several proposals to the organizations, including an expansible gas-filled packer readily set or removed from an oil well; a venturi tube designed to improve the extraction of gasoline condensate from natural gas; and a jet-powered electric generator. One of the Slick organizations is known as the Foundation of Applied Research and the other is the Institute of Industrial Research, Milam Building, San Antonio.



TOP: Shell laboratory. TOP INSET: Dr. Harold Gershinowitz, director. CENTER: Thermal analysis unit. LOWER: Conference room.







Petroleum

Crude Processing at

By CECIL SMITH,

DAILY U. S. crude production was kept at near record levels during November and refineries were able to process most of this output as they continued efforts to prevent a fuel oil shortage. While neither production nor processing reached new record highs they were not far behind recent peaks. Daily crude output during the month was only 5000 barrels under October's high mark and runs to refinery stills were 85,000 less than September's all-time record.

Stock totals at the end of November clearly indicated the seasonal changes in demand for the principal petroleum products. Gasoline stocks began their yearly buildups and at the same time the fuel oils seemed to have ended their upward swings and started back downward, a trend that will prevail until the end of the winter period.

In the years prior to this current heavy year-round demand era, this time of the year was the signal for the beginning of the slack season for refiners. The rush period was ending and they could settle to a slower gait. They could easily refine the fuel oils needed and in turn build gasoline stockpiles in anticipation of the motoring season that would come with the spring. But no such easing is possible this year. Refineries must be kept at near-capacity operation in order to meet heavy burning oil needs, and even then some areas will feel the pinch; not so much from lack of supply, but insufficient transportation facilities for distribution. If the winter should prove severe, the situation might be critical for some, and at best it will be touch-and-go.

Daily crude production in November averaged 5,258,000 barrels, a drop of 5000 a day from October's all-time peak. November's daily output topped that of a year and two years ago by 435,000 and 741,000 barrels,

Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month
1945:									
January	4,756	4,680	221,737	2,094	91,666	663	31,695	1,350	44,347
February	4,767	4,817	220,221	2,194	97,457	724	27,210	1,326	39,760
March	4,804	4,719	223,988	2,124	97,447	675	26,729	1,273	35,451
April	4,807	4,774	224,229	2,127	90,804	681	29,148	1,289	34,418
May	4,887	4,913	223,151	2,179	88,530	708	29,511	1,341	34,333
June	4,859	4,989	218,218	2,166	86,128	730	32,440	1,351	35,606
July	4,897	5,001	216,638	2,281	85,582	713	36,276	1,351	38,341
August	4,870	4,928	215,135	2,269	84,003	701	41,245	1,329	42,227
September	4,423	4,275	220,319	1,933	74,574	640	45,059	1,139	42,822
October	4,284	4,244	221,246	1,888	76,805	613	45,479	1,176	42,068
November	4,517	4,624	218,916	2,156	86,540	665	44,562	1,265	41,322
December	4,472	4,574	218,763	2,056	97,676	683	35,778	1,245	37,158
1946:									
January	4,625	4,520	223,442	1,914	102,394	787	28,990	1,224	34,573
February	4,719	4,651	227,220	1,884	104,836	823	25,511	1,243	34,008
March	4,414	4,661	221,400	1,900	104,161	816	29,922	1,213	32,995
April	4,673	4,663	222,480	1,943	98,744	773	32,064	1,247	35,206
May	4,785	4,794	221,592	2,016	93,960	753	33,385	1,220	38,932
June	4,896	4,836	223,140	2,055	91,971	777	38,824	1,219	41,492
July	4,922	4,856	224,351	2,102	87,778	793	46,439	1,163	45,446
August	4,836	4,856	224,157	2,189	86,745	765	54,068	1,159	48,186
September	4,790	4,839	222,417	2,143	87,021	796	62,019	1,150	54,012
October	4,785	4,736	222,177	2,117	85,952	788	76,780	1,090	55,580
November	4,823	4,684	226,453	2,162	88,587	791	68,145	1,101	52,735
December	4,725	4,780	224,473	2,168	92,742	805	59,912	1,159	47,094
1947:									
January	4,671	4,739	223,848	2,078	99,623	778	48,197	1,174	41,550
February	4,810	4,820	225,121	2,089	103,672	777	36,901	1,228	48,480
March	4,908	4,843	228,981	2,076	105,679	825	31,423	1,222	37,403
April	4,974	4,707	235,710	2,037	101,724	764	30,268	1,148	36,455
May	5,033	4,947	237,768	2,128	95,209	805	34,279	1,204	39,992
June	5,137	5,221	230,974	2,302	86,003	847	46,444	1,244	47,600
August	5,173	5,260	228,523	2,383	85,849	869	54,707	1,245	51,334
September	5,251	5,236	225,258	2,375	84,360	911	59,764	1,237	52,578
October	5,263	5,225	224,926	2,336	82,079	928	62,728	1,226	51,955
November	5,258	5,241	224,616	2,327	86,539	908	61,894	1,219	51,153
November, 1947 Changes:									
In Month	—5	+16	—310	—9	+4,460	—20	—834	—7	—802
In One Year	+435	+557	—1,837	+165	—2,048	+117	—6,251	+118	—1,582
In Two Years	+741	+617	+5,700	+171	—1	+243	+17,332	—46	+9,831

Trends

Near-Record Levels

Staff Writer

respectively. Texas' production in November showed a decrease of 33,500 barrels a day from October's, but the rest of the nation did very well in making up and accounted for all but 5000 barrels of the drop.

Refinery stills were charged with an average of 5,241,000 barrels of crude daily during the month, which was an increase of 16,000 barrels a day over October's runs, but which failed by 85,000 barrels of matching September's record high of 5,326,000 barrels daily. In November, 1946, and 1945, daily runs to stills averaged 557,000 and 617,000 barrels less than they did in 1947's like period. Of the nation's total refining capacity 92.4 percent operation was necessary to process November's crude.

Refinable crude stocks totaled 224,616,000 barrels at the end of November, a decrease of 310,000 barrels during the month. Those stocks were 1,837,000 barrels less than were on hand a year before, but were 5,700,000 barrels more two years ago. Crude oil stocks are now about 20 million barrels less than they were just prior to U. S. entry into the war.

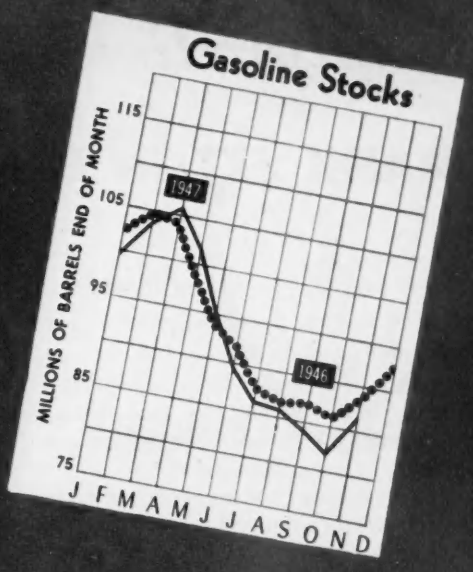
Production of gasoline during November averaged 2,327,000 barrels daily, 9000 a day under the previous month, but 165,000 and 171,000 barrels daily over the same month of 1946 and 1945, respectively. Stocks of finished and unfinished gasoline began their annual climbs during the month, gaining 4,460,000 barrels. At the end of the period they totaled 86,539,000 barrels, which was 2,048,000 barrels less than a year ago, but practically the same as two years before.

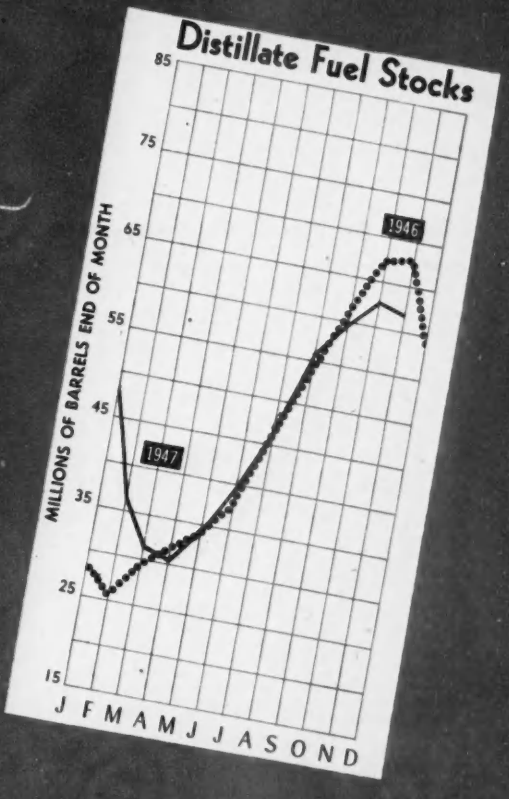
Distillate fuel oil output averaging 908,000 barrels daily for the month was off 20,000 daily from the previous month, but topped production a year and two years ago by 117,000 and 243,000 barrels daily. Stocks of distillate fuel were lowered 834,000 barrels and ended the month at 61,894,000 barrels. That amount was 6,251,000 barrels less than was on hand a year before, but exceeded stocks of November, 1945, by 17,332,000 barrels.

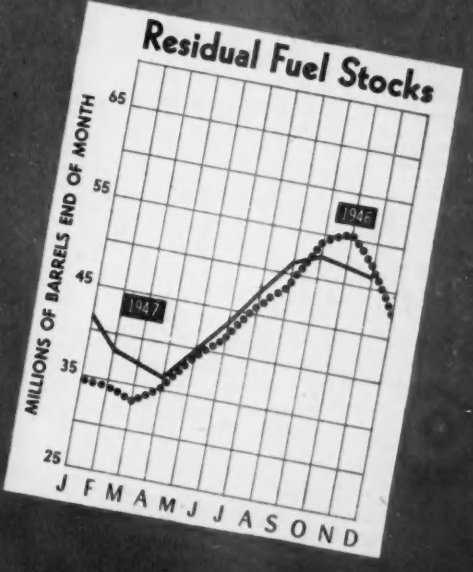
State Crude Oil Production

(THOUSANDS OF BARRELS)

STATE OR DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL 1ST ELEVEN MONTHS		
	November, 1947	October, 1947	November, 1946	% Diff. Nov.'46-'47	1947	1946	% Diff.
Alabama	1.3	1.3	1.0	+ 30.0	356	351	+ 1.4
Arkansas	79.0	77.9	79.2	— 0.3	26,915	25,917	+ 3.9
California	924.7	920.7	870.5	+ 6.2	304,190	287,922	+ 5.7
Colorado	47.5	48.0	37.9	+ 25.3	14,343	10,833	+ 32.4
Florida	0.9	0.8	0.1	+800.0	235	48	+389.6
Illinois	177.5	173.8	200.2	— 11.3	60,743	69,192	— 12.2
Indiana	18.0	17.2	17.3	+ 4.0	5,614	6,168	— 9.0
Kansas	292.1	298.0	273.1	+ 7.0	96,159	88,818	+ 8.3
Kentucky	26.6	25.6	27.1	— 1.8	8,558	9,755	— 12.3
Louisiana	451.5	443.4	414.0	+ 9.1	144,848	130.481	+ 11.0
North Louisiana	106.4	103.1	94.1	+ 13.1	33,126	27,869	+ 18.9
South Louisiana	345.1	340.3	319.9	+ 7.9	111,722	102,612	+ 8.9
Michigan	46.5	46.2	44.5	+ 4.5	14,744	15,711	— 6.2
Mississippi	108.7	104.2	80.2	+ 35.5	31,624	21,617	+ 46.3
Missouri	0.1	0.1	0.1	.....	46	47	— 2.1
Montana	24.4	24.1	21.3	+ 14.6	7,906	8,102	— 2.4
Nebraska	0.6	0.6	0.6	.....	202	250	— 19.2
New Mexico	120.2	117.6	103.4	+ 16.2	37,076	33,668	+ 10.1
New York	13.2	14.0	12.8	+ 3.1	4,398	4,459	— 1.4
Ohio	9.1	9.5	7.8	+ 16.7	2,849	2,661	+ 7.1
Oklahoma	409.8	401.6	360.8	+ 13.6	128,482	123,491	+ 4.0
Pennsylvania	32.1	35.0	35.2	— 8.8	11,543	11,921	— 3.2
Tennessee	.....	.....	.....	.....	7	9	— 22.2
Texas	2,339.5	2,373.0	2,123.2	+ 10.2	745,029	697,818	+ 6.8
Dist. 1—South Central	24.6	24.4	19.7	+ 24.9	7,350	6,471	+ 13.6
Dist. 2—Middle Gulf	162.2	162.1	150.8	+ 7.6	52,213	47,349	+ 10.3
Dist. 3—Upper Gulf	487.0	492.7	467.4	+ 4.2	159,704	153,915	+ 3.8
Dist. 4—Lower Gulf-S.W.	253.9	259.5	229.7	+ 10.5	80,104	73,062	+ .96
Dist. 5—East Central	41.5	41.1	36.7	+ 13.1	12,965	13,243	— 2.1
Dist. 6—Northeast	422.0	438.1	431.8	— 2.3	144,816	144,870	.....
Dist. 7-B—N. Central	41.4	43.7	35.8	+ 15.6	12,875	10,930	+ 17.8
Dist. 7-C—W. Central	41.7	40.7	30.4	+ 37.2	12,421	9,178	+ 35.3
Dist. 8—West	643.5	645.7	504.7	+ 27.5	185,844	165,152	+ 12.5
Dist. 9—North	133.6	135.9	125.8	+ 6.2	43.722	41,482	+ 5.4
Dist. 10—Panhandle	88.1	89.1	82.3	+ 7.0	28,539	27,908	+ 2.3
Virginia	0.1	0.1	0.1	.....	66	8	+725.0
West Virginia	7.2	7.7	7.5	— 4.0	2,371	2,703	— 12.3
Wyoming	127.4	122.3	104.6	+ 21.8	39,594	35,003	+ 13.1
Total United States	5,258.0	5,262.7	4,822.5	+ 9.0	1,687,898	1,586,953	+ 6.4







Exploration

MARK SET IN 11 MONTHS

AT THE end of 11 months 1947 had already reached a new all-time high in the number of exploratory wells completed. The previous record of 4842 wells was recorded in 1946 and at the end of November they totaled 5019, a new record and yet another month to go. For the past several months wells completed in this classification have averaged over 500, and although December would probably fall short of that figure slightly the year should account for about 5500 exploratory wells, many more than in any previous year.

During November 504 of these wells were finished, considerably less than the 609 completed a month earlier which established an all-time record for exploratory completions in a single month, but well above the average. Of these 504 November wells, 92 were rated as producers for a score of 18.3 percent successful. A month earlier 115 wells or 18.9 percent of the total found production.

In November 57 wells found new sources of crude oil, 35 were strict wildcats that opened new oil fields and 22 were semi-wildcats that located new pay strata in already existing fields. Distillate discoveries numbered 7. Also included were seven new gas areas and one gas pay, for a total of eight new gas finds.

The remaining 20 successful exploratory ventures proved major extensions to established fields.

Summary of Results of Exploratory Drilling

ITEM	Nov., 1947	Oct., 1947	ELEVEN MONTHS: JAN.-NOV. 1947	1946	Percent Diff.
Oil Discoveries	57	76	643	467	+ 37.7
New Fields	35	51	380	280	+ 35.7
New Pays	22	25	263	187	+ 40.6
Distillate Discoveries	7	11	92	65	+ 41.5
New Fields	5	4	43	28	+ 53.6
New Pays	2	7	49	37	+ 32.4
Gas Discoveries	8	11	107	98	+ 9.2
New Fields	7	9	81	71	+ 14.1
New Pays	1	2	26	27	— 3.7
Total Discoveries	72	98	842	630	+ 33.7
Extensions to Fields	20	17	175	231	— 24.2
Oil Fields	17	12	134	148	— 9.5
Distillate Fields		2	15	7	+114.3
Gas Fields	3	3	26	76	— 65.8
Total Prod. Tests	92	115	1017	861	+ 18.1
Dry Holes	412	494	4002	3549	+ 12.8
Wildcats	405	484	3888	3455	+ 12.5
New Pays			49	37	+ 32.4
Outposts	7	10	65	57	+ 14.0
Total Expl'tory Tests	504	609	5019	4410	+ 13.8
Percent Productive	18.3	18.9	20.3	19.5	
Percent Dry	81.7	81.1	79.7	80.5	

SEE TABLE ON PAGE 58

Results of Exploratory Drilling in November and First 11 Months, 1947-1946, By Districts

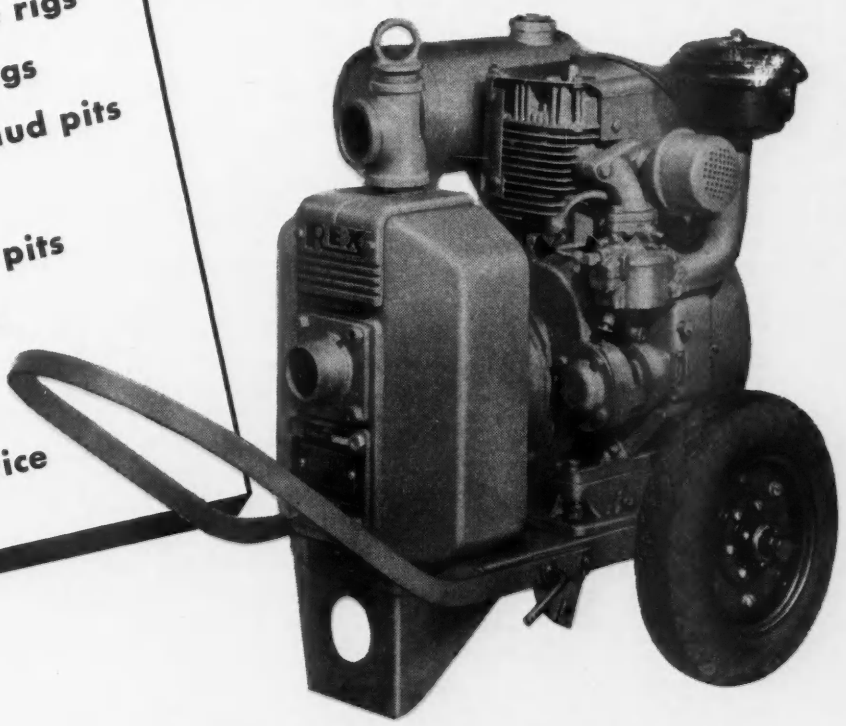
State or District	MONTH OF NOVEMBER, 1947													FIRST ELEVEN MONTHS, 1947																				
	Productive Tests										Unproductive Tests			Total Exploratory Tests	Productive Tests									Total Productive		Unproductive Tests				Total Dry		Total Exploratory Tests	
	New Fields			New Pays			Extensions			Total Productive	Wildcats	New Pays	Outposts		New Fields			New Pays			Extensions			11 Mo. 1947	11 Mo. 1946	Wildcats	New Pays	Outposts	11 Mo. 1947	11 Mo. 1946	11 Mo. 1947	11 Mo. 1946
	Oil	Gas	Dis.	Oil	Gas	Dis.	Oil	Gas	Dis.						Oil	Gas	Dis.	Oil	Gas	Dis.	Oil	Gas	Dis.											
Alabama											3			3												20			20	12	20	12
Arizona																														2		2	
Arkansas				1		1				2	5		1	8	4			4		2	1			11	11	61	1	1	63	47	74	58
California	1									1	16			17	9	1		11			7	3		31	29	243			243	229	274	258
Colorado											4			4	1	1					1	3		6	6	33		7	40	12	46	19
Florida											1			1											1	26			26	22	26	23
Georgia											1			1												4			4	2	4	2
Illinois				7			8			15	52			67	27			57	1		49	1		135	103	404			404	493	539	596
Indiana	2	1		2						5	8			13	12	1		8			1			22	15	118			118	84	140	99
Kansas	3									3	22			25	50	12					2	1		65	73	317			317	246	382	319
Kentucky	1									1	8			9	5			1			2			8	19	53			53	80	61	99
Louisiana	1		2	3						6	31			37	16	4	9	29		17	4		1	80	74	252	6	1	259	196	339	270
North Louisiana			1							1	18			19	7	1	3	2		1	1		1	16	15	170	5	1	176	113	192	128
South Louisiana	1		1	3						5	13			18	9	3	6	27		16	3			64	59	82	1		83	83	147	142
Michigan	1	1			1		2			5	30	1		36	10	4			1		5			20	26	212	1	2	215	211	235	237
Mississippi											8			8	3	1		1			3		1	9	9	83			83	69	92	78
Missouri											2			2												17			17	23	17	23
Montana											3			3	1	1			1		2			5	6	14	1	2	17	22	22	28
Nebraska																										2			2	5	2	5
New Mexico	1									1	7			8	5			1			2	1		9	5	55	5		60	48	69	53
New York																														1		1	
North Carolina																										1			1	5	1	5
Ohio								3		3	4			7		3						8		11	24	42			42	40	53	64
Oklahoma	3	1								4	36			40	71	16	1	4			4	1		97	99	490		1	491	356	588	455
Oregon																										1			1	2	1	2
Pennsylvania											2			2											12	5			5	4	5	16
South Dakota																														3		3
Tennessee											3			3												15			15	14	15	14
Texas	21	4	3	8		1	5			42	151		6	199	160	32	33	143	23	30	45	7	11	484	313	1374	31	43	1448	1283	1932	1596
Dist. 1 S. Central											15			15	9			1			4			14	7	130		1	131	92	145	99
Dist. 2 Middle Gulf		1		1						2	8		1	11	8	5	14	12	6	9	3	2	1	60	[1]	102		7	109	[1]	169	[1]
Dist. 3 Upper Gulf		1	1	1		1				4	17		1	22	15	6	9	23	8	10	4		3	78	62	157	3	9	169	132	247	194
Dist. 4 L. Gulf-S.W.	2			3						5	33		3	41	24	11	6	39	7	9	3	2	5	106	82	228	2	14	244	284	350	366
Dist. 5 E. Central				1						1	8			9	4			3			2	2		11	[2]	66	2	1	69	[2]	80	[2]
Dist. 6 Northeast			2							2	7			9	3	2	3	3		2	1		1	15	23	48	3	2	53	89	68	112
Dist. 7-B N. Central	5	1								6	17			23	36	5	1	23			1			66	[3]	217	7	1	225	[3]	291	[3]
Dist. 7-C W. Central	5									5	7			12	17			3			4			24	[4]	36	2	1	39	[4]	63	[4]
Dist. 8 West	5	1		2			4			12	16			28	21	1		15	2		16			55	47	118	5	5	128	157	183	204
Dist. 9 North	4						1			5	21		1	27	22	2		21			7		1	53	92	253	5	2	260	517	313	609
Dist. 10 Panhandle											2			2	1							1		2		19	2		21	12	23	12
Utah											1			1											1	4			4	4	4	5
Virginia																														2		2
Washington											1			1												2			2	1	2	1
West Virginia																3								3	22	7			7	11	10	33
Wyoming	1			1			2			4	5			9	6	2		4			6	1	2	21	13	33	4	8	45	19	66	32
Total U. S.	35	7	5	22	1	2	17	3		92	404	1	7	504	380	81	43	263	26	49	134	26	15	1017	861	3888	49	65	4002	3549	5019	4410

[1] Dist. 2 included with Dist. 4. [2] Dist. 5 included with Dist 6. [3] Dist. 7-B included with Dist 9. [4] Dist. 7-C included with Dist 8.

THERE'S A NEW LITTLE YELLOW PUMP –

Around the Rigs!

- Pumping water to the rigs
- Washing down the rigs
- Jetting water into mud pits
- Draining ditches
- Pumping out slush pits
- Transferring slush from pit to pit
- General dewatering service



The *new* little yellow Rex Pump is the ideal unit for all-round utility service. Because of the press-formed body, it is light in weight and easy to handle.

This new Rex Pump is amazingly durable. It's built to take a lot of punishment, to give you years of dependable, trouble-free pumping performance. If damages should occur, body can be easily repaired by welding.

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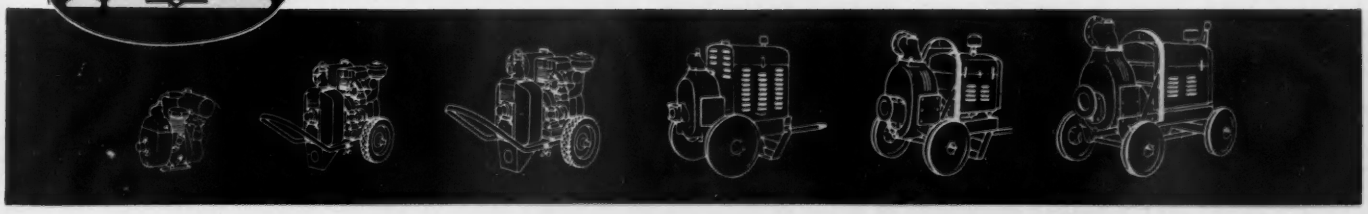
REX **OIL FIELD PUMPS**



CHAIN BELT COMPANY *of* MILWAUKEE

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in November, 1947

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		ARKANSAS—New Oil Pay						
Ouachita	Wesson	Ormond Corp's R. S. Foster 3, c sw sw sw 13-15s-19w	11- 8-47	3656	3592- 3598	Travis Peak sd; L Cre	P 135	38
		ARKANSAS—New Distillate Pay						
Columbia	Columbia	Frank & George Frankel's Lizzie Pickler 1, c ne sw ne 23-17s-21w, 3 mi s Magnolia.	11- 5-47	8076	8029- 8037	Smackover li; Jur	F 30; 10 wtr; 0.8 mln; 1/16"	
		CALIFORNIA—New Oil Field						
Monterey		Texas Co's Lombardi 1, 550 n 1260 w fr sec of 27-22s-10e, San Ardo Area, Salinas Valley.	11- 5-47	2158			P 84	10
		ILLINOIS—New Oil Pays						
Clay	Bible Grove, S.	W. Duncan's Harden-Webster Comm 1, (OWWO) sw sw ne 20-5n-7e	11-11-47	2758	2497- 2503	Cypress sd; Miss	P 26	
Clay	Bible Grove, E.	N. V. Duncan's A. A. Harmon Hrs 1, (OWWO) se se ne 27-5n-7e, extends prod. 1 mi.	11-25-47	2978	2783- 2793	Aux Vases sd; Miss	P 115; 50 wtr	
Effingham	Eberle	Nat'l Assoc. Pet Co's A. Jacobs 2, se ne sw 24-6n-6e	11-25-47	2483	2473- 2483	Cypress sd; Miss	P 32; 10 wtr	
Franklin	West Frankfort, S.	R. Bartmes et al's West Frankfort Packing Co. 1-A, sw nw 30-7s-3e, 216 fr sl 560 fr el.	11-10-47	2912	2827- 2842	McClosky li; Miss	P 248	
Gallatin	Inman, W.	Kingwood's Schiff 1, ne se ne 21-8s-9e	11-25-47	2957	1923- 1938	Palestine sd; Miss	P 32; 17 wtr	
Wabash	Maud	Ill, Mid-Continent's T. Grundon 1, sw sw nw, 35-1s-13w	11- 4-47	2308	2287- 2293	Cypress sd; Miss	P 200	
White	Trumbull	W. E. Witt's J. W. Williams et al 1 (OWWO), sw sw se, 6-5s-9e, extends prod 1 mi n.	11-25-47	3382	3288- 3292	McClosky li; Miss	P 48; 18 wtr	
		ILLINOIS—Oil Field Extensions						
Clay	Bible Grove, E.	Calvert & Willis' Shields 1, se nw sw 23-5n-7e, ¾ mi se extension	11- 4-47	2953	2878- 2891	Cypress sd; Miss	P 10; 20 wtr	
Clinton	Shattuc	F. F. Turner's F. Mann 1, sw nw ne 28-2n-1w, ½ mi w extension	11-30-47	1295	1288- 1295	Cypress sd; Miss	P 44	
Edwards	Albion Consol.	N. Redwine's McKinley-Walker Comm. 1, ne nw ne 31-1s-14w ¾ mi e extension.	11- 4-47	3198	3150- 3159	McClosky li; Miss	P 25	
Gallatin	Roland	C. E. Brehm's J. W. Oliver et al 1, nw ne ne 29-7s-8e, 1¼ mi sw extension	11-18-47	2115	2098- 2115	Waltersburg sd; Miss	P 30	
Jasper	Willow Hill Consol.	Robinson & Puckett's C. J. McCord 1, nw ne ne 23-7n-10e, ¾ mi n extension.	11- 4-47	2597	2549- 2554	Rosiclare li; Miss	P 87	
Richland	Noble	Calvert & Willis' C. Yunker et al 1, ne nw ne 14-3n-8e, ½ mi extension	11-10-47	3090	3002- 3030	Rosiclare li; Miss	P 84; 14 wtr	
Wayne	Boyleston Consol.	B. J. Taylor et al's A. R. Burkett 1, se ne ne 18-1s-7e, 1½ mi extension	11-10-47	3345	3155- 3160 3239- 3243	Aux Vases sd; Miss Rosiclare li; Miss	P 40; 150 wtr	
Wayne	Johnsonville, W.	B. J. Taylor's B. Watkins 1, ne ne ne 26-1n-5e, ½ mi n. extension	11-10-47	3087	3054- 3070	McClosky li; Miss	P 120	
		INDIANA—New Oil Fields						
Gibson		Joe Riezmik's M. & C. Weber 1, ne se se 30-2s-9w, 2 mi sw Francisco, 1 mi fr prod.	11-30-47	1942	1819- 1823	L. Renault li; U. Miss	Sw 66	
Posey		V. R. Gallagher-Farm Bureau's J. J. Anderson 1, ne ne sw 25-5s-14w	11-14-47	2408	2024- 2030	Palestine sd; U. Miss	P 66	
		INDIANA—New Oil Pays						
Gibson	Francisco, W.	W. A. Schuller-H. W. Ramsey's Frank Steiner 1, se nw nw 24-2s-10w, 1 mi fr prod.	11- 7-47	1962	1956- 1962	McClosky li: L. Miss	P 175	
Gibson	Princeton	Princeton Mining's Dr. Virgil McCarty Comm 1, sw se ne 13-2s-11w	11- 1-47	2163	2157- 2163	McClosky li; L. Miss	P 120	
		INDIANA—New Gas Field						
Sullivan		Chas. Lowery's H. McGrew 1, e½ se sw 1-8n-10w	11-14-47	2404	2235-	Devonian li; Devo	1.3 mln	
		KANSAS—New Oil Fields						
Barton	Esfeld	Bennet & Roberts Inc's Esfeld 1, se se nw 15-16-11, 1½ mi e Kraft-Prusa pl.	11-18-47	3358	3354- 3358	Arbuckle li; Ord	P 138	37
Butler	Joseph	Cox & Burns' Joseph 1, ne se ne 18-24-5e, 2 mi se Hazlett pl.	11-18-47	2503	2491- 2503	Mississippi li; Miss	P 15	
Pawnee	Ash Creek, Sw.	Mid-Continent Pet Corp's Bowman 1, se se nw 11-21-16, 1½ mi w Ash Creek, S. pl.	11-25-47	3792	3777- 3789	Arbuckle li; Ord	P 480	37
		KENTUCKY—New Oil Field						
Hopkins		O. O. Borden et al's O. C. Whitfield 1-K-25-2, 6 mi se Slaughters, 2½ mi e Hansen, 6 mi ne Madisonville.	11- 7-47	2340	2296- 2325	Tar Springs sd; U. Miss	P 64	
		NORTH LOUISIANA—New Distillate Field						
Union	D'Arbonne	Pan-American Prod Co's Elva Rugg 1, c ne se 31-20n-1w, 8 mi s 5 mi w Farmerville.	11- 1-47	8890	8386- 8404	Bodcaw sd; Jur	F 88; 4.1 mln; 11/64"	59.1
		SOUTH LOUISIANA—New Oil Field						
Terrebonne	"Block 32"	Kerr-McGee Oil Industries Inc's State 1, Blk 32, Lse 754, s 3 deg 35 min 59 sec, e 63,619.36 fr Tri. Sta. "End", 12 mi out in Gulf of Mexico.	11-14-47	2564	1734- 1750	Miocene	F 600; 24 wtr; ½"	25
		SOUTH LOUISIANA—New Oil Pays						
Avoyelles	Dave Haas	Atlantic Ref Co's Haas Investment Co. 2, 1811.3 n and 748.3 w of sec Sect 9-2s-2e, ¼ mi nw disc. well.	11-15-47	8638	8470- 8490		F 144; 1/8"	42
Iberville	Whitecastle	Shell Oil Co's A. Wilbert 40, 1730 s 0 deg 9 min e & 1210 s 89 deg 27 min w fr nec 8-11s-12e.	11- 1-47	4328	3740- 3750	Miocene	F 130; 1/8"	23.8
Lafourche	Bayou des Allemands	Amerada Pet Corp's C. E. Gheens 14, 9445 s 4544 w of nec 13-15s-20e in Sect 37.	11-10-47	8407	8130-8166	Miocene	F 189; 1/8"	32.3
		SOUTH LOUISIANA—New Distillate Field						
Beauregard		Vincent & Welch's Vincent & Welch-Houston Oil Co. 1, fr nec 14-6s-13w, go s 00 deg 15 min e on el 1980, th n 89 deg 12 min w parallel to nl 660 to loen, 1½ mi e Bancroft prod.	11-12-47	8425	7899- 7904		F 58; 0.6 mln; 1/64"	59.7
		MICHIGAN—New Oil Field						
Allegan		Leonard C. Sleep's Utton 1, nw se sw 34-4n-13w, Salem Twp. ¾ mi se Salem, S fld, 2 mi n Brenner fld.	11-11-47	1692	1689- 1691	Traverse li; Devo	P 15; 5 wtr	
		MICHIGAN—Oil Field Extensions						
Allegan	Salem	P. K. Degenther's J. & R. Thomas 1, ne se sw 13-4n-13w, e extension	11- 7-47	1656	1628- 1656	Traverse li; Devo	F 10	
Ottawa	Talmadge, S.	Carl E. Grimes' Bauma 1, se se nw 35-7n-13w	11-10-47	1880	1860- 1880	Traverse li: Devo	P2	
		MICHIGAN—New Gas Field						
St. Clair	Algonac	Ray W. Matlock's Folkert & Kane 1, c se ne 29-3n-16e, Clay Twp.	11-21-47	344	320- 344	Antrim sh; Devo	0.05 mln	
		MICHIGAN—New Gas Pay						
Mecosta	Wheatland	Carter Oil Co.'s Smith Pet Co 1, (OWWO) ne sw sw 9-14n-7w, Wheatland Twp.	11-21-47	1452	1399- 1412	Stray sd; Miss	0.8 mln	
		NEW MEXICO—New Oil Field						
Eddy	Loco Hills	Harvey Yates' Ballard 3-B, (OWDD) 990 fr s&wl Sect 8-18s-29e, 2 mi s extension.	11- 9-47	2660	2620- 2634	Grayburg li; Perm	F 85; 2"	
		OHIO—Gas Field Extensions						
Ashland	Ashland	E. A. Fierbaugh et al's M. E. Clouser 1, Lot 24, Ruggles Twp. 2 mi n Savannah	11-10-47	4504	2453- 2458	Clinton sd; Sil	0.3 mln.	
Medina	Ashland	Carl H. Edson's E. H. Miller 1, Lot 31, Litchfield Twp. 1 mi se Litchfield	11- 8-47	2936	2910- 2917	Clinton sd; Sil	0.15 mln	
Morgan	Brush Creek	Underwood et al's Lawrence Wiseman 1, se sw 14 Deerfield Twp, 1½ mi se Tridelphia.	11-21-47	4397	4295- 4320	Clinton sd; Sil	0.3 mln	
		OKLAHOMA—New Oil Fields						
Cotton		Bridwell Oil Co'e Witt 1, 1100 n 1100 e sw nw 17-4s-10w, 1 mi se Cache Creek pl.	11-20-47	1259	1250- 1259	Cisco sd; Penn	P 8	35
Osage		O. E. Dempsey's Osage Tr 18-1, se se ne 15-20n-10e, near Shell Creek Lake,	11-13-47	2186	2173- 2186	Tucker sd; Ord	F 150; 7 mln	38
Payne	Goodnight, N. E.	F. G. & W. J. Fox's Gibson 1, (OWWO) nw se sw 8-17n-2e, 3 mi e Coyle pl 4 mi sw of Perkins.	11-20-47	4917	4228- 4258	Red Fork sd; Penn	F 600	
		OKLAHMOA—New Gas Field						
Noble		Sinclair Prairie Oil Co's Bradbury 1, (OWWO) ne se nw 29-22n-1w	11- 6-47	5139	4720- 4787	Mississippi li; Miss	0.9 mln	
		TEXAS—District 2 (MIDDLE GULF COAST)—New Oil Pay						
Victoria	Coletto Creek	Jergins Oil Co's Katie Willemin 1, 1152 fr swl, 2100 fr sel 248-ac lse in Pedro Gallardo Gr, 250 se Coletto Creek and s of Coletto Creek fld.	11-21-47	5003	4302- 4321		F 107; 1/8"	24
		TEXAS—District 2 (MIDDLE GULF COAST)—New Gas Field						
Refugio	West Vidauri	P. R. Rutherford et al's J. F. Welder Hrs 1, 5769 fr el 5960 fr sl Welder Tr, on 606-ac lse, Mrs. Anna Jackson Sur, 5 mi n-nw Greta fld.	11-28-47	6235	4869- 4876		2.9 mln; ¼"	
		TEXAS—District 3 (UPPER GULF COAST)—New Oil Pay						
Harris	Pierce Junction, S.	McCarthy & Gulf's R. C. Mowery 1, 1350 fr nl 990 fr wl of Jas. Hamilton Sur 53, on 80-ac lse.	11-17-47	12940	7564- 7570		F 92; 11/64"	28.8
		TEXAS—District 3 (UPPER GULF COAST)—New Distillate Field						
Fort Bend		J. W. Frazier & Grubb & Hawkins' J. R. Farmer 1, 80-ac lse, I&GN Sur Sect A-353, 466 fr s&wl of tr, 466 fr s'ly wl & 466 fr sl of Sur, 1½ mi sw Clodine fld.	11-23-47	7665	7415- 7420		F 100; 2.9 mln; ¼"	59

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		TEXAS—District 3 (UPPER GULF COAST)—New Distillate Pay						
Wharton	West Bernard	Tide Water Assoc Oil Co's C. B. Stephens 1, 6 mi se Lissie Twst, 4250 due n Hudgins 1, disc well, 660 fr se&swl of Stephens & McElhinney 480-ac Tr in 500-ac lse, J. M. Rose Hrs Sur.	11- 1-47	7859	7680- 7698		F 25; 3.4 mln; 8/64"	49
		TEXAS-District 3 (UPPER GULF COAST)—New Gas Field						
Harris		Union Prod Co's Homer J. Moore 1, 717.28-ac lse, Jno. E. Durkee Sur, Sect 20, Blk 4, 2½ mi se Langtry 1, gasser at No. Houston, 466 fr el 512 fr nl Lot 17, Reed Subdn.	9- -47	8500	7705- 7710		no gge	
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Oil Fields						
Nueces		Lonnie Glasscock's Sam Counties et al 1, 467 fr e'ly el 467 fr n'ly sl of 322.58-ac lse and of share 4, Wright Lds Partn, V. L. de Herrera Gr, 1¼ mi n-ne of n ext. Agua Dulce fld.	10-23-47	5136	5095- 5099		F121; 2/4"	31.7
Zapata	Joe Moss	Moss & Watson's Amelia de O. Vela 4, 2204 fr sel 2189 fr nel Subd of share 3, El Grullo Gr, Blk 29, in 2628.78-ac lse, 1 mi n Charco Redondo fld.	11-14-47	771	760- 771		P 27	20
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Oil Pays						
Nueces	Robstown	Comanche Corp's A. Studer 1, 330 fr el 1525 fr sl Sect 7, Lot 3, Gec. H. Paul's farm Blk Subd of Driscoll Rch, M. L. de Herrera Gr, 1 mi nw Robstown.	11-30-47	8001	5046- 5054		F 75; 1/8"	41
Nueces	Luby	Sun Oil Co's G. H. McCann 1, (OWDD) 467 fr nl 1400 fr wl 561.3-ac lse, Canutillo Colony Ditch Co. Sur.	11- 1-47	6445	6131- 6135		F 16; 1/8"	32.2
Jim Wells	Premont, E.	Magnolia Pet Co's A. A. Seeligson 107, 1650 fr wl, 3620 fr sl Jas. A. Houghton Sur, 20,887.4-ac lse, 1320 w disc. well.	11-12-47	6105	4688- 4695 4773- 4783		F 90; 2/4" F 43; 2/4"	34.9 ....
		TEXAS—District 5 (EAST CENTRAL)—New Oil Pay						
Grayson	Sherman	Standard of Texas' H. L. Rising et al 1, 330 fr s&el of m/ely sec of Rising 97.35-ac Tr in J. B. McAnair Sur. 2 mi n Sherman. 1600 w of disc well.	11- 9-47	3264	3219- 3224	Strawn Series sd; Penn	P 116	36
		TEXAS—District 6 (NORTHEAST)New Distillate Fields						
Shelby		Humble's Elzie Fleming et al 1, fr nec of S. Francois Sur, go 700 s alg el, th 1720 e at ra to loc in John Halley Sur, 2393 e Huxley fld prod.	10-24-47	7450	6596- 6610	Pettit li; L. Cre	F 96; 8 mln; open	54.9
Harrison		Stanolind's George Slaughter 1, 440 s 880 e of n/ly nwc of 166.6-ac lse, 440 fr nl 4800 fr wl 3200 fr el J. E. White Sur, 9 mi n Marshall in Woodlawn Area.	10-25-47	10374	6358- 6440	Pettit li; L. Cre	F 430; 9.6 mln; open	....
		TEXAS—District 7-B (NORTH CENTRAL)—New Oil Fields						
Jones		M. G. Hansbro's A. B. Hunter 1, 330 fr s & el of nw¼ Sect 27 Blk 15 T&P Sur, 4 mi n Hawley.	11- 6-47	2210	2203- 2210		P 50; 10 wtr	39.2
Shackelford		Danciger O&R Co. & W. J. Rhodes' W. Y. Davis 1-A, 330 fr s&wl of s¼ of nw¼ Sect 13 Blk 12 T&P Sur, 4 mi w Albany.	11-13-47	5000	4973- 4988	Ellenburger dolo; Ord	P 170	45
Taylor		W. W. Harvey & R. Maguire's Mrs. M. N. Ferrell 1, 330 fr n&wl Blk 1, Grimes CSL Sur, 2½ mi se Merkel.	11- 4-47	2469	2456- 2469	Flippen li; Penn	F 102; 7/32"	40
Taylor		Geochemical Survey's J. Patterson 1, 990 fr n&wl Blk 17, Grimes CSL Sur, Lge 148, 1½ mi ne Merkel.	11- 4-47	2240	2225- 2240	Dotham sd; Perm	F 111; 7/32"	41
Throckmorton		Fred M. Manning Inc's R. A. Brown "K" 1, 2310 fr sl 330 fr wl Sect 261 BBB&C Sur, 5 mi nw Throckmorton.	11-16-47	5315	4456- 4461	Caddo li; Penn	F 606; 4/16"	....
		TEXAS—District 7-B (NORTH CENTRAL)—New Gas Field						
Palo Pinto		Ernest Lloyd's Vera D. LaNeve 1-A, 2117 fr ne&sel, P. Miller Sur, 6 mi w Graford.	11-14-47	1744	1290- 1302		4.7 mln	....
		TEXAS—District 7-C (WEST CENTRAL)—New Oil Fields						
Crockett	Tippett	Byrd-Frost & Gulf Oil Corp's Mayberry 1, 330 fr ne&sel Sect 39 Blk 31 H&TC Sur, 6 mi sw Crockett pl.	11- 4-47	7796	6325- 6340	Wolfcamp li; Perm	F 1391; ½"	41.6
Crockett		Continental Oil Co's University "A-9" 1-S, 2402 fr nl, 330 fr el Sect 9, Blk 47, Univ. Lds. 5 mi s Barnhart pl.	11- 8-47	2355	2115- 2190	San Andres li; Perm	P 3	33.3
Crockett		Continental Oil Co's University "A-8" 1-S, 2388 fr nl 2420 fr el Sect 8 Blk 47 Univ. Lds., 5 mi s Barnhart pl.	11- 3-47	2200	2130- 2200	San Andres li; Perm	P 17	33
Reagan		Continental Oil Co's University "B-8" 1, 1980 fr n&wl Sect 8, Blk 49, Univ. Lds., 2½ mi sw Barnhart pl.	11-19-47	2465	2280- 2350	San Andres li; Perm	P 7	32
Runnels	Ballinger	Southern Minerals Corp's K. V. Northington 1, 1400 fr ne&sel of Sur & 1400 nw of nwc of N. Taylor Sur 363 in T. Pratt Sur 365½, 1½ mi w Ballinger.	11- 1-47	4170	4095- 4170	Bend li; Penn	P 32	42
		TEXAS—District 8 (WEST)—New Oil Fields						
Gaines		Los Nietos Oil Co's J. A. Sparks 1, 660 fr n&el Sect 396 Blk G, CCSD&RGNG Sur 12 mi w Seminole, 2 mi se Riley, N fld.	10-25-47	7290	6860- 6920	Clear Fork dolo; Perm	P 155	30.7
Gaines		Skelly Oil Co's M. S. Doss 1, 1980 fr sl 660 fr wl Sect 394 Blk G CCSD&RGNG Sur, 12 mi w Seminole.	11-19-47	6940	6929- 6940	Clear Fork dolo; Perm	P 99	31.8
Hockley		Seaboard Oil Co's C. M. Wrenchey 1, 660 fr s&el Lab 25, Lge 732, Taylor CSL Sur, 8 mi nw Levelland.	11-11-47	4901	4758- 4802	San Andres dolo; Perm	P 176	31
Reeves	Orla	Texzona Prod Co & Louis Crouch's Tunstill Bros 1, 330 fr n&el Sect 10 Blk 56, T-2, T&P Sur, 6 mi ne Orla.	11- 1-47	3308	3268- 3280	Delaware sd; Perm	F 71; 2/4"	42
Reeves		C & B Oil Co & M. G. Hansbro's G. C. Fraser Jr. et al 1, 330 fr sl 1650 fr el Sect 3, Blk 56, T-2, T&P Sur, 6 mi ne Orla, Tunstill Area.	11-14-47	3312	3284- 3312	Delaware sd; Perm	F 205 ¼"	42
		TEXAS—District 8 (WEST)—New Oil Pays						
Andrews	Fullerton	T. P. Coal & Oil Co's Emily M. Jackson 17-E, 1980 fr sl, 1830 fr wl Sect 17 Blk A-32, PSL Sur.	11- 2-47	9910	7970- 8000	Wolfcamp li; Perm	F 1147; 1"	40
Winkler	Keystone	Gulf Oil Corp's Keystone Cattle Co. 27-H, (OWDD) 2200 fr nl 440 fr wl Sect 6, Blk B-2, PSL Sur.	11-12-47	5048	4940-		F 707; ½"	41.4
		TEXAS—District 8 (WEST)—Oil Field Extensions						
Reeves	Orla	Texzona Prod Co. & Louis Crouch's John Camp 1, 330 fr n&wl Sect 14, Blk 56, T-2, T&P Sur, 1 mi sw extension.	11- 1-47	3298	3280-	Delaware sd; Perm	F 61; ¼"	42
Andrews	Three Bar	Stanolind's University 1-AN, 660 fr n&wl Sect 21, Blk 11, Univ. Lds. Sur. ½ mi se extension.	11-18-47	8300	8176- 8266	Devonian	F 406; ¼"	44
Crane	University-Waddell Ellenburger	Gulf Oil Corp's Waddell 101-E, 660 fr s&el Sect 27, Blk B-25, PSL Sur, ½ mi n extension.	11-16-47	10835	10710-10819	Ellenburger dolo; Ord	F 1104; 2½"	47.3
Gaines	Adair	McAlester Fuel Co's Sarah E. Wilson Bice 1, 660 fr nl, 1980 fr wl Sect 9, Blk C-31, PSL Sur, 1 mi s extension.	10-24-47	4903	4825- 4902	San Andres li; Perm	P 148	33.2
		TEXAS—District 8 (WEST)—New Gas Field						
Pecos		Phillips Pet Co's Omega 1, 143 fr sl 1110 fr wl Sect 11, Blk 143, T&STL Sur, 20 mi se Ft. Stockton.	11- 8-47	3380	1460- 1500	Rustler (or Salado) sd; Perm.	0.7 mln	....
		TEXAS—District 9 (NORTH)—New Oil Fields						
Clay	Acme	S. D. Johnson & Acme Die & Machine Co's Carl Mobley 1, 3103 fr el 5250 fr nl of T. Morehead Sur, 3 mi nw Deer Creek.	11- 4-47	4036	4010- 4036	Strawn sd; Penn	F 193; ¼"	43
Cooke		A. V. Grant's Wm. Hyman 1, 330 fr e&sl of lse, P. P. Anderson Sur, 10 mi ne St. Jo.	11-25-47	2245	2240- 2245		P 98	....
Montague		Bay Pet Corp & Anderson Prichard's Watson Hrs et al 1, 330 fr s&el Blk 84, J. H. Belcher Sbdn, 2 mi s Belcherville.	11-19-47	5680	5677- 5683	Bend cgl; Penn	F 1605; 11/64"	41
Wichita		A. Goldsmith et al's R. Lee Kempner 1, 330 fr n&wl Lot 55 Blk 4, A. Repsch Sur, 4 mi nw Holliday.	11-22-47	4738	3900- 3925	KMA sd; Penn	F 600	42
		TEXAS—District 9 (NORTH)—Oil Field Extension						
Archer	Chalk Hill, N.	Henry Grace Prod Co's L. F. Wilson 1, 330 fr s&el of n½ of sw¼ Blk 72 ATNCL Sur, Lot 3, 7 mi ne Archer City, 6000 se extension.	11-16-47	4021	3995-4018		F 1224; 4/16"	42
		WYOMING—New Oil Field						
Niobrara		Intermountain Pet Co's Gov't 1, ne ne ne 8-36n-62w, Old Woman Creek Area.	11-27-47	1480	1373-	Leo sd; Penn	P 5	....
		WYOMING—New Oil Pay						
Big Horn	Torchlight	Stanolind's Orchard Unit 1, 2310 fr nl 1050 fr el sw se ne 24-51n-93w....	11-14-47	3141	3044- 3078	Tensleep sd; Penn	F 1632; open	35.2
		WYOMING—Oil Field Extensions						
Fremont	Steamboat Butte	Brinkerhoff & Sohio's Tribal 2, 1650 fr nl 330 fr w, nw sw nw 9-3n-1w, s extension.	11-14-47	6912	6886- 6912	Tensleep sd; Penn	P 600	28.9
Weston	Mush Creek	Morton & Phillips' Gov't-Torgeson 1, c nw se 7-44n-63w, 1¼ mi nw extension.	11-27-47	4335	4276-	Newcastle sd; U. Cre	P 7	....

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plio, pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

Completions

MAY REACH 33,600 FOR 1947

THE industry completed 2992 wells in November to boost the year's 11-month total to 30,625 wells, almost 9 percent more than the 28,186 wells completed in the same period of 1946. The final month of the year should account for almost 3000 wells more to bring the year's total to about 33,600. That will prove 1947 to be the most active drilling year since the peak year of 1937 when slightly over 35,000 wells were drilled.

Although this year will not equal the all-time high in number of wells drilled, it will establish a new record in total footage drilled. In the peak year a little less than 105 million feet was drilled and that still stands as the record, but when the final count for 1947 is made that total will have been topped by about 8 million feet. Had not the industry been hampered by a number of shortages of materials and equipment, principally tubular goods, and had been free to drill as many holes as it desired, it is reasonable to believe that 1947 would have surpassed previous years in all phases of drilling as it will in the producing and refining of crude oil and its products.

November's wells failed by almost 300 of equalling October's peak for the year, but compared favorably with those of September. Compared with November, a year ago the month's completions showed an increase of about 450 wells. The month's drilling resulted in 1545 wells completed as crude oil producers, 26 producers of distillate and 312 gas wells. Service wells, salt water disposal and input wells, amounted to 190, and 876 proved to be dry holes.

At the end of November there were 4871 active rigs in the U. S. This total included those that were actually making hole, rigging up and temporarily shut down on location.

Well Completions in the United States During November, 1947, and Cumulative for Year

(Figures compiled by WORLD OIL staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon, and Allegany fields of Pennsylvania and New York from The Producers' Monthly.)

STATE OR DISTRICT	MONTHLY COMPLETIONS, NOVEMBER, 1947									TOTAL COMPLETIONS				CUMULATIVE TOTAL January-November				Rigs in Operation (Drilling, Rigging Up and Shut Down)		
	NEW WELLS								Total Drilled Deeper											
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New		Nov., 1947	Oct., 1947	Nov., 1946	Footage November, 1947	Wells 1947	Wells 1946	Percent Diff.	Footage 1947	Nov. 30, 1947	Oct. 31, 1947	Nov. 30, 1946
Alabama				3				3		3	4	2	18,121	26	16	+ 62.5	109,682	5	6	6
Arizona															2	—100.0		1		
Arkansas	24	1		14				39	1	40	47	19	163,867	302	176	+ 71.6	1,228,924	43	37	33
California	159		4	35				198		198	194	155	757,996	1,807	1,742	+ 3.7	7,406,449	283	273	306
Colorado	18			4				22		22	23	15	122,062	191	150	+ 27.3	1,043,066	67	72	52
Florida				1				1		1	3	3	6,020	28	25	+ 12.0	151,910	4	5	9
Georgia				1				1		1			3,120	4	2	+100.0	15,065	1	1	
Illinois	97		3	112				212		212	190	215	534,140	1,903	2,166	— 12.1	4,854,953	212	229	300
Indiana	28		2	26				56		56	80	41	106,710	567	472	+ 20.1	1,006,366	76	79	68
Iowa																				1
Kansas	98		35	61			4	198		198	319	185	651,626	2,372	1,995	+ 18.9	7,511,665	320	348	287
Kentucky	27		24	31				82		82	67	84	174,622	792	795	— 0.4	1,517,719	84	99	113
Louisiana	104	6	10	57			3	180		180	188	127	951,906	1,501	1,300	+ 15.5	8,032,949	200	198	185
North Louisiana	61	2	9	24			3	99		99	134	66	287,938	899	736	+ 22.1	2,704,698	73	76	79
South Louisiana	43	4	1	33				81		81	54	61	663,968	602	564	+ 6.7	5,328,251	127	122	106
Maryland																		1	1	1
Michigan	29		7	44				80	1	81	83	51	180,733	662	725	— 8.7	1,521,149	137	133	103
Mississippi	20	5	1	13				39		39	54	27	303,729	437	229	+ 90.8	3,657,226	62	69	71
Missouri				2				2		2	7		660	37	30	+ 23.3	20,328	6	6	4
Montana	17		6	6				29	1	30	30	16	59,415	217	247	— 12.1	491,760	73	77	56
Nebraska												2		3	5	— 40.0	7,987	1	4	4
New Mexico	32		8	9				49	6	55	44	37	213,969	534	421	+ 26.8	2,181,210	116	124	107
New York	99		1	1	63			164		164	185	92	232,991	1,691	1,064	+ 58.9	2,393,808	202	228	113
North Carolina														1	4	— 75.0	6,370			1
Ohio	35		37	49				121	2	123	131	100	317,916	1,240	1,210	+ 2.5	3,459,135	248	262	245
Oklahoma	136		20	102		2		260	4	264	296	321	828,098	3,347	2,984	+ 12.2	10,134,523	532	506	527
Oregon														1	2	— 50.0	8,500			
Pennsylvania	112		53	20	95	23		303	7	310	329	327	538,831	3,212	3,827	— 16.1	5,553,776	425	421	318
South Dakota												2			3	—100.0		1	1	4
Tennessee				4				4		4			7,906	17	12	+ 41.7	26,352	17	11	
Texas	481	14	45	260				800	17	817	912	643	3,636,524	8,690	7,693	+ 13.0	37,162,741	1,276	1,247	1,202
Dist. 1—S. Central	18			20				38	1	39	60	18	121,326	343	166	+106.6	1,194,820	58	49	34
Dist. 2—Middle Gulf	30	4	1	10				45	1	46	59	1	317,745	573	[1]	[1]	3,495,590	69	68	[1]
Dist. 3—Upper Gulf	33	2	1	35				71		71	95	60	460,609	792	632	+ 25.3	5,051,176	125	112	88
Dist. 4—L. Gulf-S.W.	36	4	3	46				89	2	91	113	131	471,567	1,029	1,464	+ 9.4	5,429,481	109	119	162
Dist. 5—E. Central	6			9				15		15	23	[2]	67,103	152	[2]	[2]	731,492	30	28	[2]
Dist. 6—Northeast	20	4	8	12				44	1	45	55	47	238,949	461	665	— 7.8	2,360,189	57	69	89
Dist. 7-B—N. Central	23		6	38				67	2	69	88	[3]	199,728	816	[3]	[3]	2,466,396	105	106	[3]
Dist. 7-C—W. Central	24			12				36	1	37	24	[4]	132,880	269	[4]	[4]	898,835	59	54	[4]
Dist. 8—West	189		1	24				214	8	222	183	162	1,065,985	1,871	1,697	+ 26.1	8,886,222	441	422	428
Dist. 9—North	77		2	48				127	1	128	161	208	363,334	1,909	2,743	— 0.7	4,979,866	107	100	303
Dist. 10—Panhandle	25		23	6				54		54	51	17	197,298	476	326	+ 46.0	1,668,674	116	120	98
Utah				1				1		1			6,012	4	5	— 20.0	20,155	13	12	5
Virginia															2	—100.0				
Washington				1				1		1	1		4,319	2	1	+100.0	15,321	1	1	
West Virginia	9		56	14				79	2	81	73	65	212,505	800	731	+ 9.4	2,150,864	371	365	420
Wyoming	20			5				25	2	27	37	14	105,427	237	150	+ 58.0	1,074,830	93	82	64
Total United States	1,545	26	312	876	158	25	7	2,949	43	2,992	3,297	2,543	10,139,225	30,625	28,186	+ 8.7	102,764,783	4,871	4,897	4,605

[1] Dist. 2 included with Dist. 4. [2] Dist. 5 included with Dist. 6. [3] Dist. 7-B included with Dist. 9. [4] Dist. 7-C included with Dist. 8. [5] Part of Bradford field now included in New York; formerly, all was carried in Pennsylvania.

New Geophotometric MAPPING TECHNIQUE

By W. O. BASHAW, Republic Exploration Company

HAILED as an important improvement in the art of surveying, the new geophotometric mapping technique eliminates the need for field readings and thereby reduces the margin of error to a minimum. Readings and the actual topographic scene are photographed and made a permanent record. The method is particularly adaptable to gravity meter work as well as for large scale surveys conducted by junior engineering personnel where results of more than one crew may be checked in a central office by a senior engineer.

A NEW photographic method of surveying, particularly adaptable to gravity meter work, has been perfected which eliminates all direct readings in the field by recording both the horizontal and vertical control permanently and photographically on film.

Both controls are combined on the same frame at the same time with speed, accuracy, and consistent dependability achieved by a photographic method of recording. Distance, direction, and elevation difference are all obtained on one picture with one shot (Figure 1). The resultant field data are therefore completely free of the human element and at the same time the instrumentman is relieved of the usual strain of taking direct readings under adverse field conditions while operating under pressure of volume output requirements.

Compared with the transit this means elimination in the field of (1) stadia-reading for distance; (2) rod-reading; (3) vertical angle-reading for elevation difference; and (4) horizontal angle-reading for direction. Thus, four readings and four chances for making errors on every instrument setup are eliminated, which means that in a day's work averaging 50 instrument setups, a total of 200 chances for making errors in field readings are eliminated.

Readings Made in Office

These same chances for making errors are now transferred to the computer in the office who does not have to contend with adverse weather conditions, heat waves, and the interruption of driving from one setup to the next between readings. All of the readings made in the office on the film may be checked at any time by an assistant computer, a procedure which would hardly be economically feasible of duplication in direct field readings. Only three readings are required on the film to obtain the same information as given by the four above-mentioned readings required in the field.

If an error is made in the office readings and a traverse fails to close within the allowable limits, the entire traverse may be re-run at any time in the office without the need for sending the field crew and equipment back to the area for a check on results.

When working in rough areas, the need for special terrain corrections for gravity meter stations can be seen visually on the film at the time the traverse is run in the office, thereby disclosing the reason for certain anomalous conditions which otherwise might go undetected if the need for such corrections were overlooked by engineers in the field.

The film also may be used to furnish a visual check on the geological outcrops in connection with studies of surface geology. Thus, on exposed stratigraphic sections the elevations, dips, contacts, thicknesses, etc., of various geological formations may be studied in detail. The same is true in locating, identifying, and recording old survey lines, land lines, section corners, or other permanent property markers. Enlarged prints of such features aid in relocating these at later dates.

Accuracy of Results

All measurements in the office are made directly on the film-negative using a micrometer reading device of suitable magnification. The micrometer eyepiece now in use makes it possible to measure vertical angle differences to within six seconds of arc as compared to 60 seconds with transit readings taken to the nearest minute of arc on the vertical circle.

In connection with vertical angles it should be mentioned that the plane of the film is always parallel with the plane

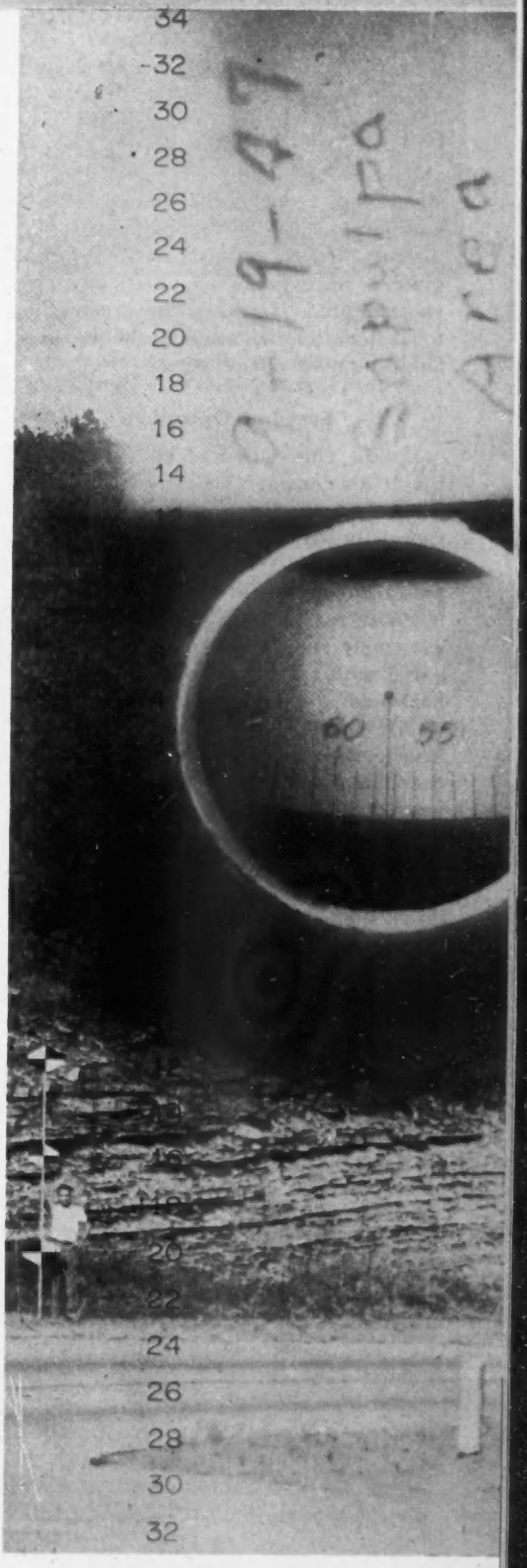


FIGURE 1. Photographically recorded field survey shot. Vertical line of figures on the glass slide of camera is the mil scale by which the target intervals and one target position are measured, thereby obtaining distance and elevation difference. Insert shows the direction of the rod from the instrument.

of the rod, which in turn is always at right angles to the line of sight because the instrument is always level for all shots. This condition is not realized with the transit in turning vertical angles because the line of sight is not at right angles to the rod and a secondary correction is needed for precise work.

Stadia distances may be read to an accuracy of ± 3 feet in 1000 feet with the target spacing now used on the fixed-target stadia rod. Rod levels are also used in the photographic method to make the most of the accuracy that is built into the instrument.

With the lens now in use an overall vertical angle range of ten degrees is possible with the instrument in the level position allowing a range of five degrees above or below the HI level line of sight. The vertical angle range of the photographic instrument is a function of the focal length and may be varied over quite a wide range to practically any value desired. However, the greater the focal length the smaller the vertical angle range and vice versa.

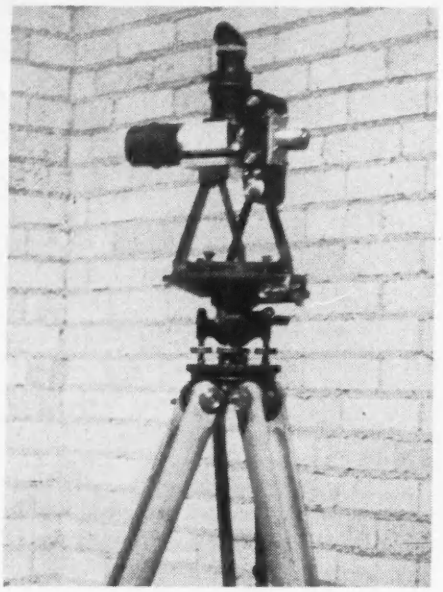


FIGURE 2. Mounted on the standard transit tripod, the instrument weighs about as much as the standard surveying equipment which requires but accurate leveling to enable permanent records to be made for both back and fore sights.

Speed of Operation

By the elimination of all readings in the field a considerable increase in speed is realized for any given shot. This is especially true where heat waves are present which greatly affect the speed and accuracy of direct visual readings, but are "frozen" on the film due to the extremely short exposure time as compared with the low visible-frequency of heat waves. This absence of heat-wave interference on the film is partly due also to the film being more sensitive to the blue-green region of the spectrum than to the red or longer wave-length regions of the visible spectrum.

The elimination of all readings in the field also eliminates the need for writing down such readings in note form, which means a further increase in speed and a further reduction in chances for errors in the field work. By the virtual elimination of the need for reruns in the field, a still greater overall increase in speed of operation is effected in two ways: (1) in the individual station to station setups; and (2) in the overall cumulative effect of long range results. It should be emphasized that all of this increase in speed is accompanied by a corresponding increase in accuracy to a point approaching the accuracy of the Y-level.

Instrument Operation

The field operation of the instrument is very simple. All that is required is to level the instrument, sight on the rodman, and snap the picture. Under average conditions the exposure time will run somewhere between 1/40 and 1/100 of a second when using fine grain film. Good results are obtained easily in cloudy weather by proper exposure. The usual field system of alternate backsights and foresights is used in running extended profiles and traverses. The main requirement for good results is that the instrument must be perfectly level at the instant the picture is taken, which is accomplished easily by simply watching the level bubble as the shutter is released.

Long years of training and apprenticeship are no longer required to obtain best results. A day or two of instruction on the camera is sufficient to enable the average person who is familiar with general field procedure to obtain consistent results with a speed and accuracy comparable with that of the most skilled and experienced instrumentman on any of the conventional type surveying instruments. This greatly reduces the time and cost of training competent engineering personnel and permits rapid expansion of the crew when needed.

The photographic instrument is light in weight, ruggedly constructed and simple in design (Figure 2). It weighs about the same as the average transit and is easily kept in adjustment. It is constructed in such a manner that a direct and positive visual check can be made on the adjustment of the instrument in the field using the customary two-peg method and direct stadia distance readings. Adjustment is made easily and readily in the field by the instrumentman.

General Uses

The photographic method of surveying may be used in connection with geophysical work, especially for gravity meter surveys where speed and accuracy are of prime importance. It also may be used for reconnaissance surveys of lease roads, highways, public works projects, well elevations, topographic and geologic mapping, or other large scale surveys where the accuracy required does not exceed that of third order leveling. Considering the increase in speed and accuracy of results, the cost of operation is less than that of the transit, especially in view of the fact that a highly trained instrumentman is not required for its operation.

The new instrument and technique combine engineering qualities designed to provide the greatest number of operational advantages, as well as ease and simplicity of operation with speed and accuracy. In general, the technique probably is best adaptable to large-scale surveys conducted by junior engineering personnel where results of more than one crew can be checked in a central office by a senior engineer.

About the Author: W. O. Bashaw was born at Shawnee, Okla. Since graduation from the University of Oklahoma in engineering physics in 1934, he has been in seismograph, gravity and magnetic survey work. Several years ago he conceived the principle of "geophotometric mapping" and with James R. New as codesigner, perfected and built the first instrument. He is a member of AAPG, SEG, Seismological Society of America, American Association for the Advancement of Science, American Geophysical Union, Texas Academy of Science and Southwest Texas Geological Society and others. He recently was elected vice president of Republic Exploration Company in charge of gravity meter exploration with headquarters at Tulsa.

Unitized Cable Tool DUMP BOXES

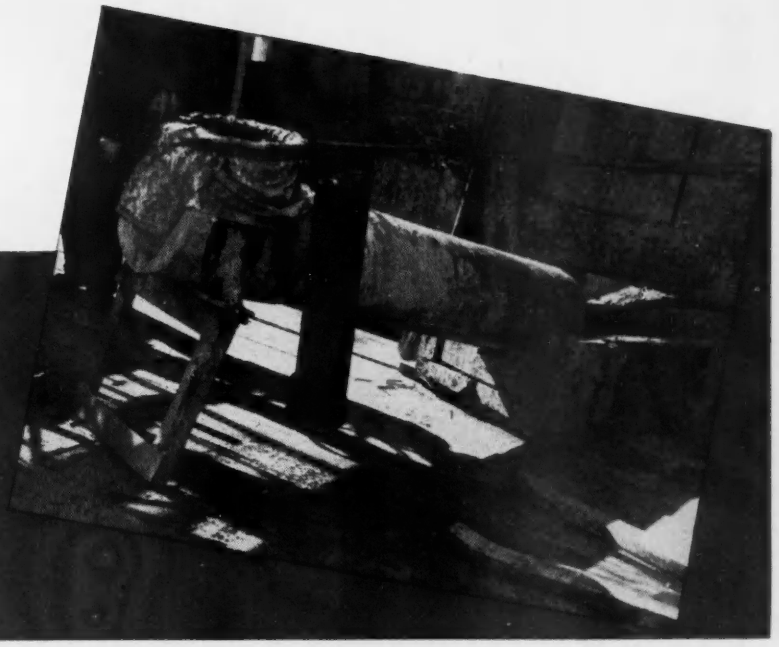


FIGURE 1. Pivoted at the downstream end of the 15-inch diameter pipe, this dump box can be raised up and leaned back against the derrick enclosure to allow free movement of men and tools, including the circle jack. Elevation and slope of the box assure rapid sluicing away of bailings.

By GILBERT M. WILSON
Staff Writer

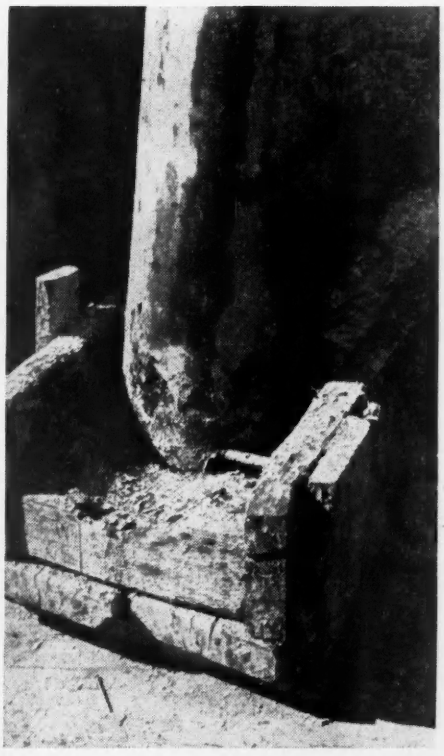


FIGURE 2. A one-inch round bar, threaded at each end, is passed through both the wooden trough and the lower bottom edge of the dump box pipe member. Block at head of trough has been dished out slightly to center pipe to help prevent back-wash of fluid as bailer is dumped.

AN EFFICIENT dump box can save time on the average cable tool rig. During the routine drilling of a well, five minutes saved in each bailing operation means five minutes more that the bit can be making hole. Multiplied by the hundreds of times the hole is bailed, this could spell the difference between profit and loss on a location.

Of the numerous types of dump boxes in common use from Montana to Texas, two seem to have outstanding qualities, and merit detailed descriptions, for despite the prevalence of rotary drilling rigs, there still exist many fields where cable tools must be used for drilling-in and many in which cable tool drilling from grass roots down still is common.

Figure 1 illustrates a retractable or folding type of dump box which was designed by a cable tool contractor operating in the Cut Bank field of Montana. Extremely popular with the drillers and tool dressers, this box, when not in use, may be lifted up and swung back out of the way, leaving the derrick floor clear for movement of tools, pipe, and, even more important, the unhindered rigging and operation of the circle jack. In addition, the floor remains clear to allow frequent hosing down, removing causes for accidents.

Hinged Base

The all-steel box consists of an eight-foot length of 15-inch pipe, closed at one end, and to which has been welded a short vertical neck, the latter of large enough diameter to accommodate the largest bailer that would be used. To provide a stand which would support the box and establish sufficient slope to assure rapid removal of cuttings and mud, a steel, flat foot was welded to the underside of the large diameter pipe. To this foot was hinged a square steel framework which forms a sturdy support when the unit is in the operating position.

This framework, measuring two feet square and made of two- and three-inch angle material welded together, holds the box steady against possible side sway. The lower end of the box rests on the end of a wooden trough, the latter projecting just inside the derrick enclosure several feet, and is anchored at

SPEED UP of any operation on a cable tool rig adds to effective hole-making time and reduces cost per foot drilled. Methods for bettering dump-box performance are outlined here, with suggestions for adapting the equipment to various rig setups.

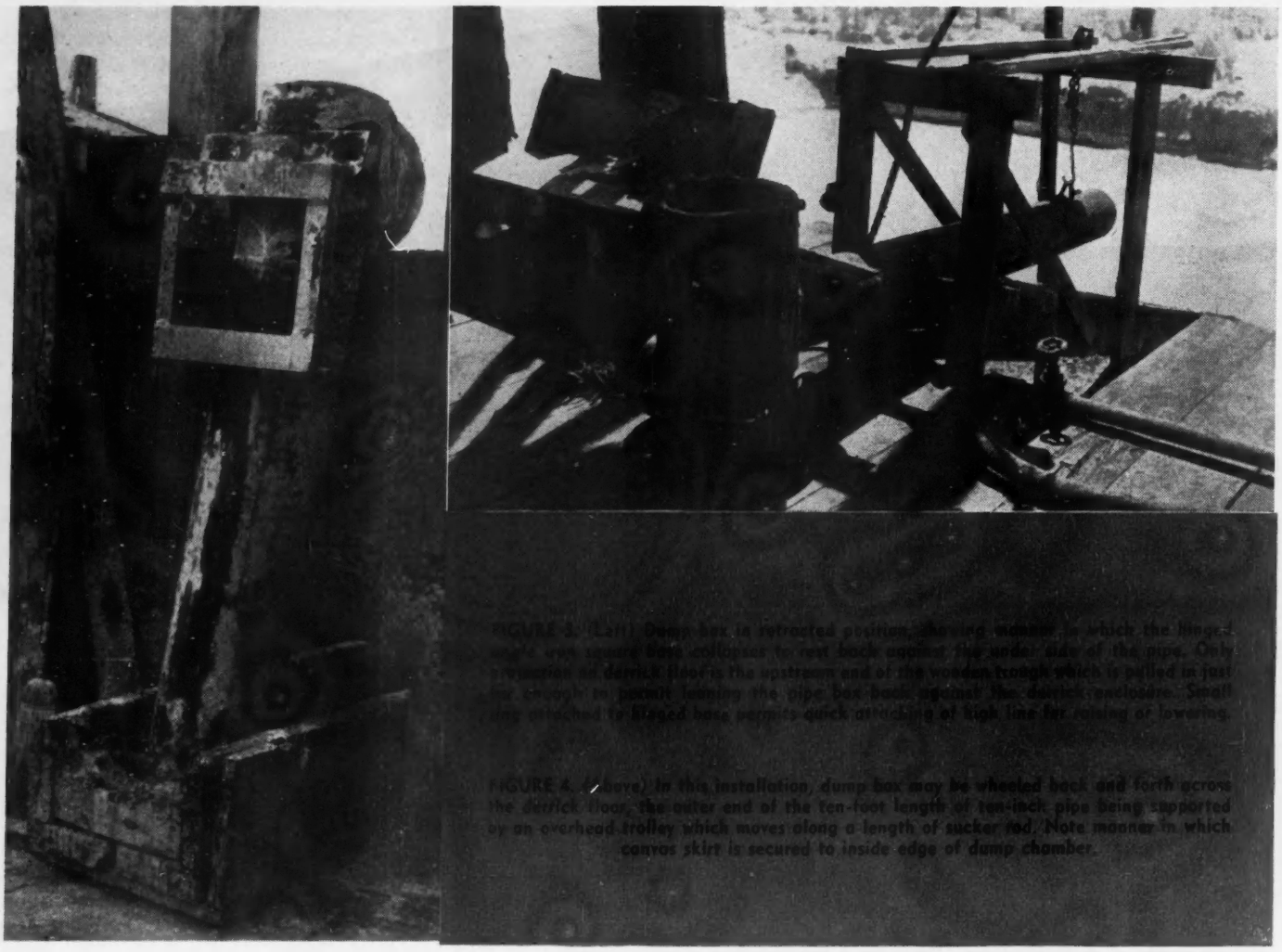


FIGURE 3. (Left) Dump box is retracted position, showing manner in which the hinged support assembly collapses to rest back against the under side of the pipe. Only obstruction on derrick floor is the upstream end of the wooden trough which is pulled in just far enough to permit leaning the pipe box back against the derrick enclosure. Small ring attached to hinged base permits quick attaching of high line for raising or lowering.

FIGURE 4. (Above) In this installation, dump box may be wheeled back and forth across the derrick floor, the outer end of the ten-foot length of ten-inch pipe being supported by an overhead trolley which moves along a length of sucker rod. Note manner in which canvas skirt is secured to inside edge of dump chamber.

that point by means of a one-inch round bar. The bar passes through one side of the wooden trough (Figure 2), through the lower edge of the pipe and on out through the other side of the trough. Cast iron washers and nuts hold the bar in place. The block at the head of the wooden box is dished out to provide a saddle in which the pipe will lay when in the operating position.

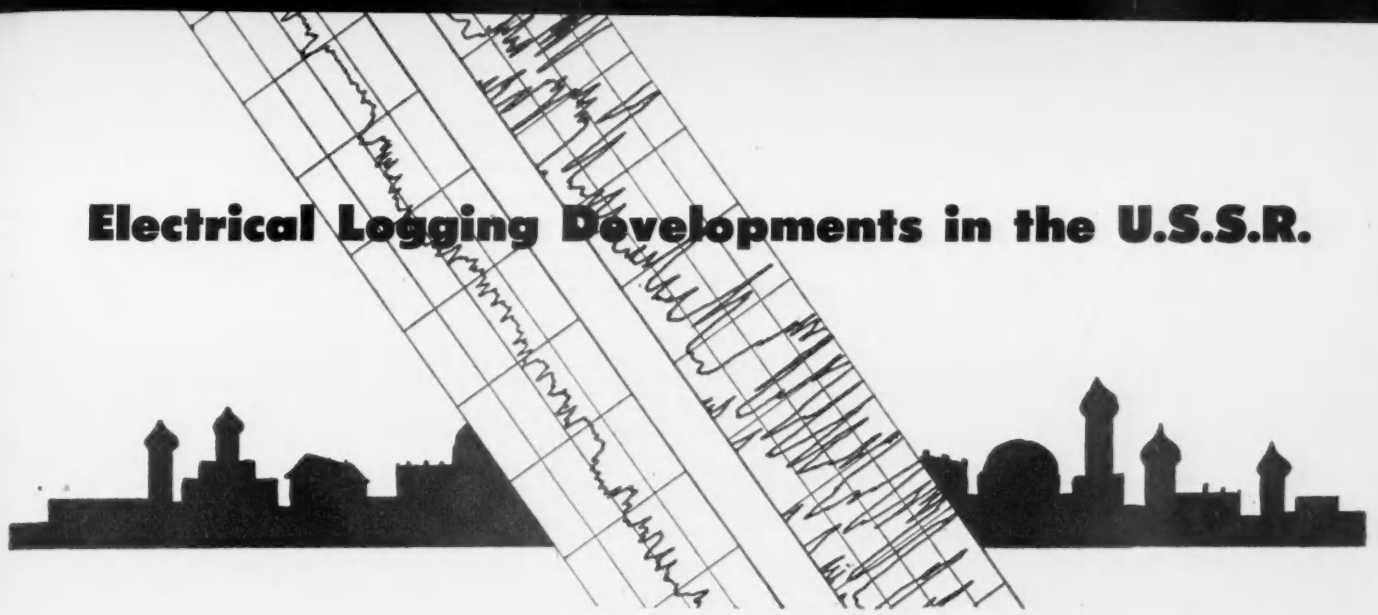
Wheel-Mounted Unit

When not in use, the dump box is picked up and leaned back against the side of the rig, the one-inch bar serving as a pivot. As shown in Figure 3, the hinged support at the forward end of the box falls down by its own weight and lays against the underside of the pipe. If the end of the wooden trough is brought inside the derrick far enough, the dump box will go over past vertical and rest in that position without need for tying it back. A small steel ring welded in a link secured to the two-foot square stand provides a place where the high line may be quickly engaged when lifting or lowering the dump box.

A type of box which finds favor among drillers in a West Texas field utilizes a somewhat different method of removing the unit from the vicinity of the well. Illustrated in Figure 4, the head end of the box rests on a pair of wheels, and the outer end is suspended from a small pulley which runs along an overhead track. The dump end of the device consists of a two-foot length of 15-inch casing set vertically and mounted on an axle and a pair of iron wheels. The trough portion, a ten-foot length of ten-inch pipe, is welded to the vertical section at a slight angle as shown. The length of the ten-inch pipe was determined by the distance between the wellhead position and the end of the wooden trough which carries cuttings on down to the adjacent slush pit. The outer end of the movable trough is supported by a chain and small pulley, the latter running along a horizontal length of sucker rod which rests upon a framework of 2x6 planks erected beside the derrick floor. Eliminating much of the splash usually occurring when the bailer is dumped is the improved method of securing the canvas skirt which is hung inside the dump section. The material is held in place by a split ring which holds it against the inner wall of the chamber. Bolts, with nuts on the outside, are drawn up to hold the skirt tightly.

In comparing the two types of boxes, each section has certain advantages which might make it more desirable to a particular operator. The swing-back installation, for example, while similar in construction to the other, is too heavy to be lifted by hand and requires a lifting line to swing it up or down. The wheeled unit, however, can be pushed back by one man, but requires a somewhat greater amount of construction work, to wit, the trolley supporting framework, when it is installed on a new location.

Both, however, have the advantage of being movable. Time required to rig them up or tear down is comparatively small, and because of their greater height above slush pit level, with consequent increased slope, cuttings are sluiced out of the way with little need for constant shoveling out of the ditches. Cuttings or fluid samples may be obtained readily since the units are above floor level and more accessible. Each of the units described may be made up by a welding shop using, for the greater part, salvaged materials. Their simplicity assures long service with little need for maintenance or other attention.



Electrical Logging Developments in the U.S.S.R.

Part 2

Resistivity of Mud-Invaded Formations

By HUBERT GUYOD

Well-Logging Consultant, Houston

AN IMPORTANT characteristic of most formations is non-uniformity. In a given bed there usually is vertical non-uniformity as well as horizontal non-uniformity. As a result the physical properties of a formation, for example resistivity, vary from one point to another. Nevertheless, it usually is possible to divide many geologic formations into individual beds in such a manner that the properties of each bed remain reasonably constant over a certain distance, provided average values encompassing several cubic feet of material are involved.

Consider a permeable formation, a sand for example, penetrated by a bore hole and partly invaded by the drilling mud. Let R and R_w represent the sand resistivity in the non-invaded zone and the resistivity of its interstitial water, respectively. These two quantities are related by the following classical expression:

$$R = F R_w \qquad (1)$$

where F is a fundamental electrical characteristic of the formation concerned. F is called the formation factor, and its value is independent of the resistivity of the interstitial water. Therefore, if the original interstitial water is entirely replaced by another water, mud filtrate for example, the following relation can be written:

$$R_i = F R_m \qquad (2)$$

where R_m and R_i represent the mud filtrate resistivity and the resistivity of the mud-invaded zone, respectively. The mud filtrate resistivity almost equals the resistivity of the mud itself[1] and these two quantities will here be assumed to be equal.

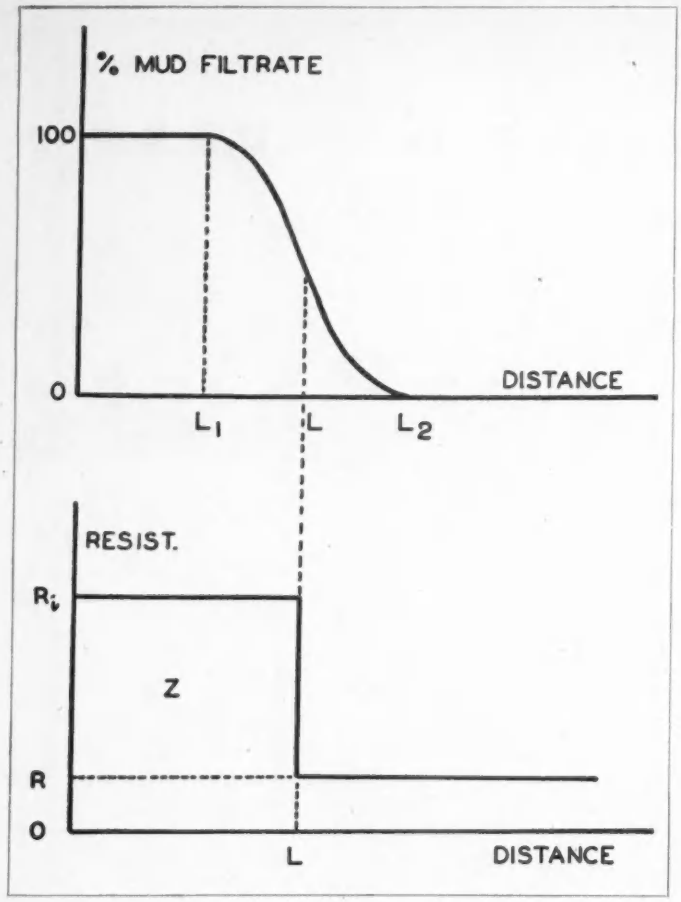
Invasion Pattern

Close to the bore hole, the sand concerned is usually entirely invaded by the mud and, in this zone, its resistivity equals R_i. Far from the bore, there is no invasion and the sand resistivity equals R. Between these two points there is an intermediate zone where only part of the interstitial water is displaced. The foregoing is tentatively illustrated by the upper curve of Figure 6, which represents the amount of mud filtrate in the sand (percent of pore space) as a function of the distance from the bore wall. L_1 denotes the distance up to which there is 100 percent invasion, and L_2 the distance where the mud invasion stopped altogether.

As far as electrical logging is concerned, it is convenient to simplify the foregoing picture by assuming that there is a uniformly and fully invaded zone Z up to a distance L, the numerical value of L being comprised between L_1 and L_2. Beyond this distance, the sand is assumed not to be invaded. The resistivity of zone Z equals R_i, while that of the medium beyond Z equals R. This simplified distribution is represented by the lower curve of Figure 6. If the distance L_2-L_1 is not too great with respect to L_1, the foregoing simplification is certainly justified. Unfortunately, no data are available on the extent of the zone of transition.

The preceding discussion refers to the horizontal resistivity distribution at a given level and along a given horizontal direction. Generally, the mud invasion at a given level is reasonably uniform in every direction and the foregoing discussion applies therefore to all azimuths.

Because of vertical non-uniformity, the distance L varies in terms of depths, perhaps as illustrated by the hypothetical graph shown at the bottom right of Figure 7. If there are no gross inhomogeneities, the average degree of invasion for the whole bed concerned, and therefore the average radial resistivity distribution, can be represented by a curve which is more or less as shown in the upper right corner of Figure 7. The sand resistivity equals R_i close to the bore, then drops to the value R when the distance from the bore increases to a value L_3. In the analysis of electric logs it has been found that the foregoing resistivity distribution is approximately equivalent to the simpler distribution illustrated in the upper left corner of



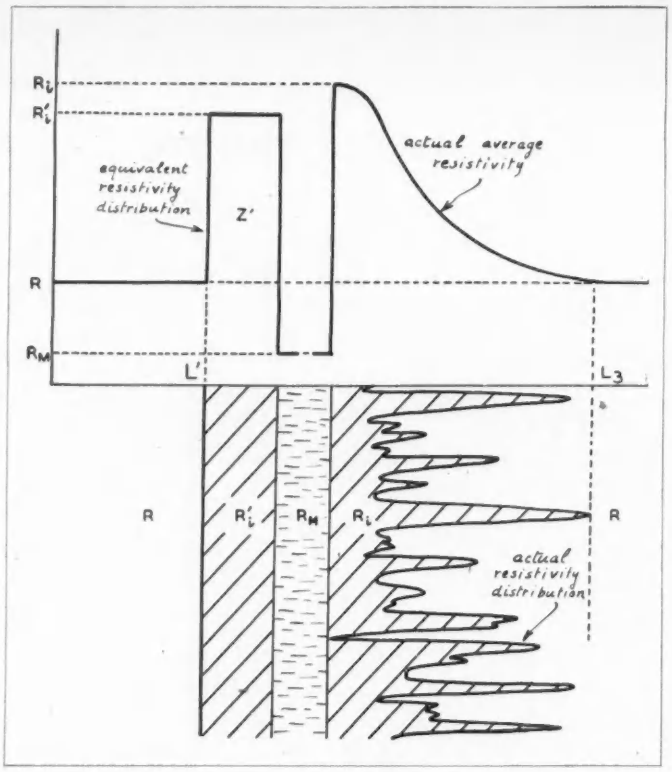


FIGURE 6 (left). Radial resistivity distribution in mud-invaded formation.

FIGURE 7 (above). Actual and equivalent resistivity distribution in mud-invaded formation. (After Dakhnov, 1941.)

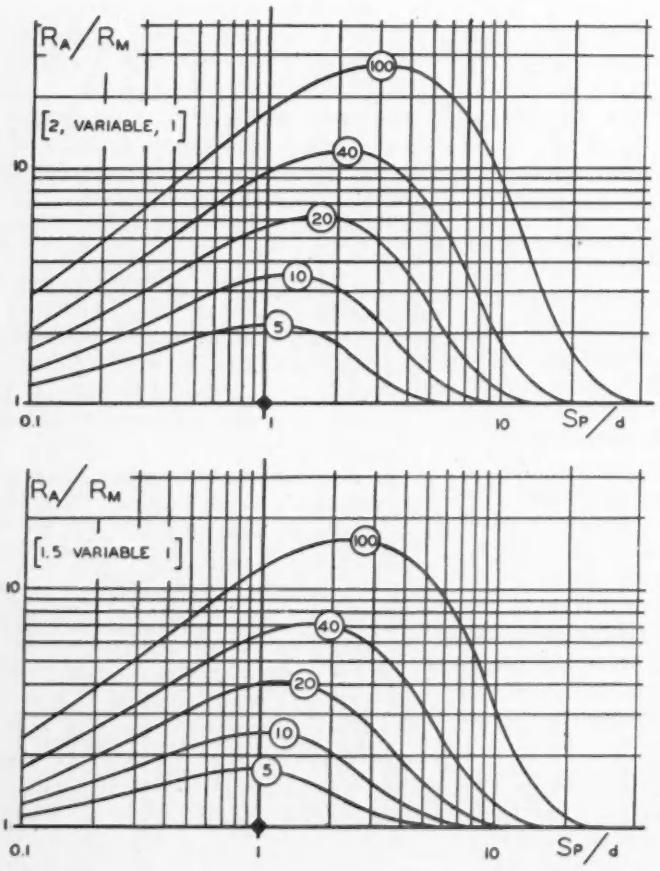


FIGURE 8. Two-electrode arrangement departure resistivity charts for thick mud-invaded formations. Figures in circles indicate resistivity contrast R'_i/R_m of invaded zone. Formation resistivity equals mud resistivity. Diameter of invaded zone is twice hole diameter for top chart, and one and a half hole diameter for bottom chart. (After Alpin, 1938,)

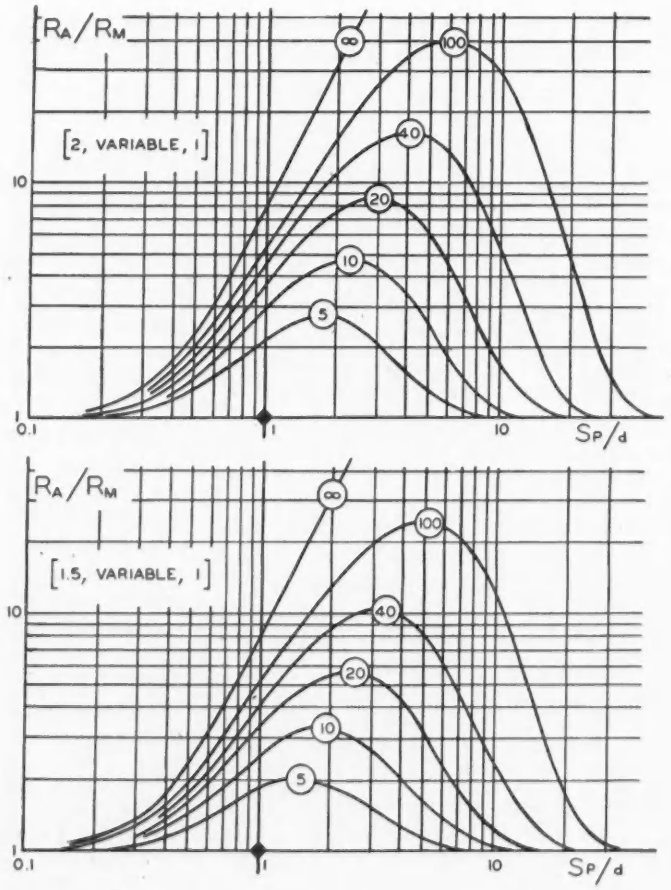


FIGURE 9. Same as Figure 8, except that data are for three-electrode arrangements. (After Alpin, 1938.)

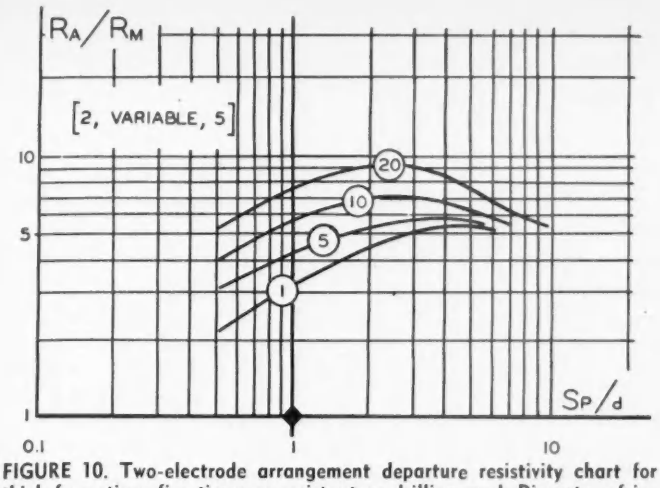


FIGURE 10. Two-electrode arrangement departure resistivity chart for thick formations five times as resistant as drilling mud. Diameter of invaded zone is twice hole diameter. Figures in circles indicate resistivity contrast R'_1/R_m of invaded zone. (After Alpin, 1938.)

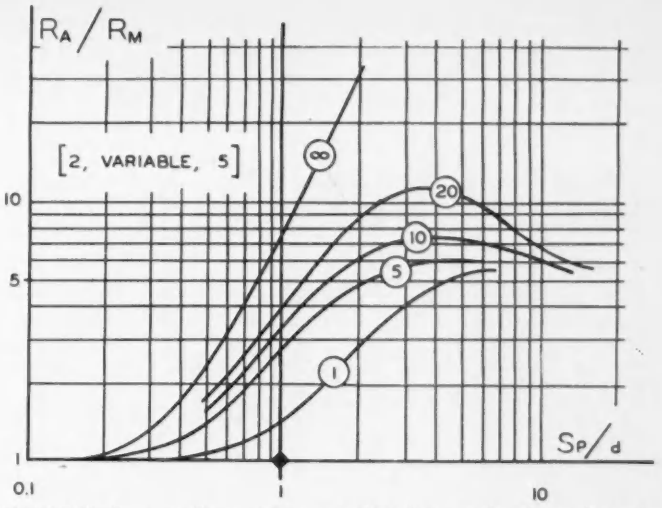


FIGURE 11. Same as Figure 10, except that data are for three-electrode arrangements. (After Alpin, 1938.)

Figure 7, namely to a cylindrical uniform zone Z′ of resistivity R'_1 beyond which the medium of resistivity R is situated. The thickness L′ is less than L_a, and resistivity R'_1 is somewhat smaller than R_1. Although the quantities R'_1 and L′ are difficult to establish mathematically, in many instances they can be determined experimentally from resistivity graphs. Therefore, it is permissible to consider the foregoing simplified resistivity distribution, rather than the actual one, at least for certain problems. Only this simplified pattern will be considered in this work.

The Three Media

In the logging of an invaded formation we have then to consider the three foregoing media:

The mud column: diameter d, resistivity R_m; the invaded zone: diameter D, resistivity R'_1; the uncontaminated formation: resistivity R.

Resistivity of invaded zone. The numerical value of the formation factor F of any formation is always greater than unity. It ranges from about 3 for very porous sands to 100 or more for well cemented beds, and the average value for petroleum reservoirs exceeds 6. Referring to relation (2) it can then be seen that the resistivity of the invaded zone of a permeable bed is always much greater than the mud resistivity. Therefore, in this work only cases where R'_1 is greater than R_m need be considered.

Resistivity of non-invaded zone. With the exception of the fresh water bearing formations found close to the surface, the interstitial water of a permeable bed is more saline than the usual drilling mud, therefore R is smaller than R_1, if the bed does not contain petroleum.

In the case of a petroleum reservoir,

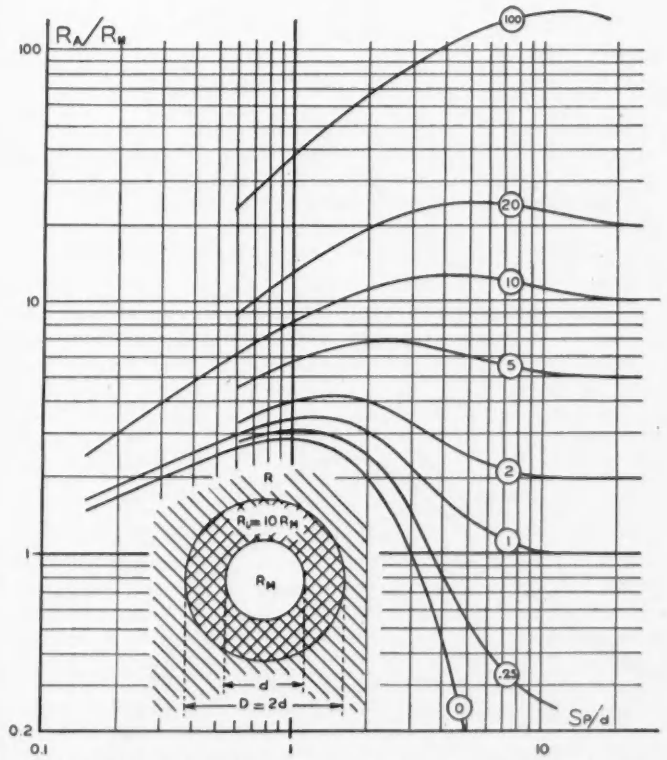


FIGURE 12. Two-electrode arrangement departure resistivity chart for thick mud-invaded formations. Diameter of invaded zone is twice hole diameter. Resistivity of invaded zone is ten times mud resistivity. Figures in circles indicate resistivity contrast R/R_m of formation. (After Dakhnov, 1941.)

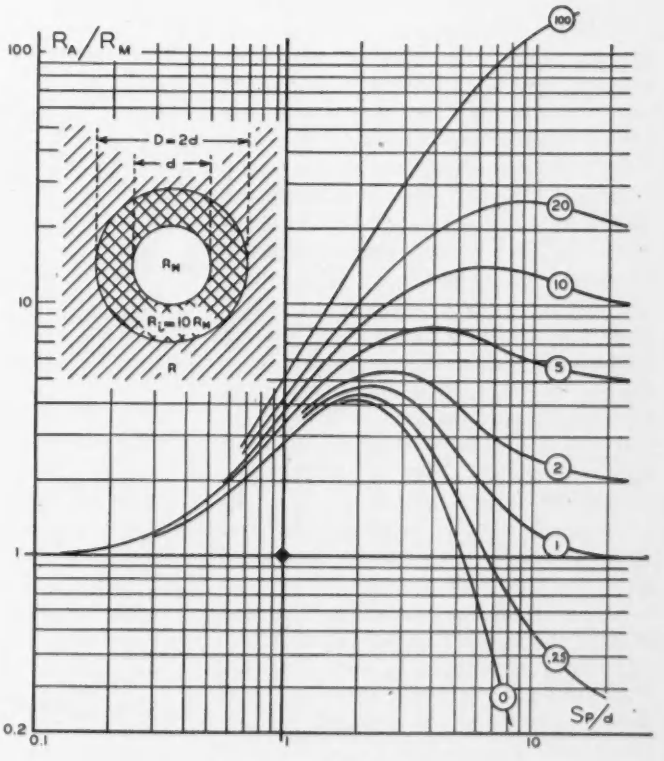


FIGURE 13. Same as Figure 12, except that data are for three-electrode arrangements. (After Dakhnov, 1941.)

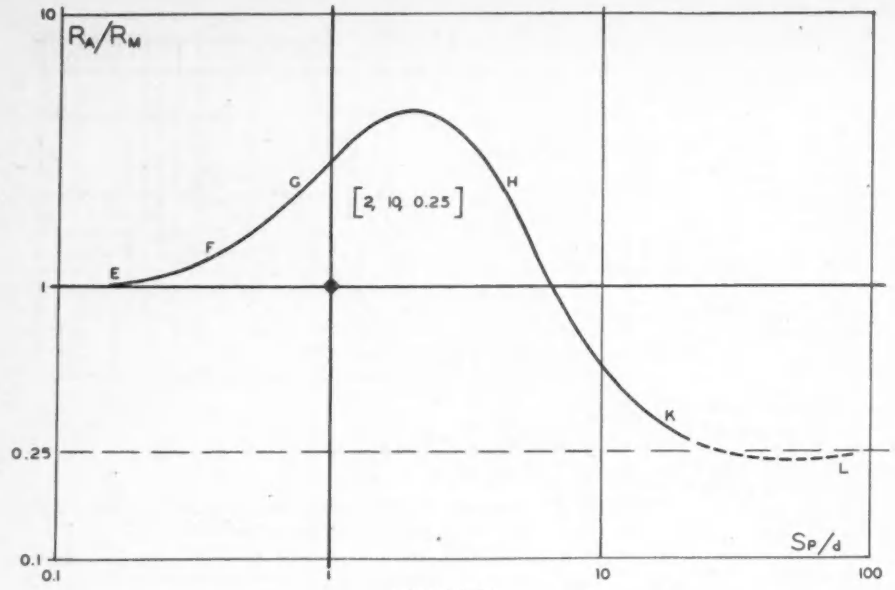


FIGURE 14

its resistivity can be either greater or smaller than R_t according to the petroleum saturation.

Departure Charts

Departure charts similar to those established for two media (non-invaded formations) can be calculated also for thick formations invaded by mud. Some of them are shown on Figures 8 through 13. The even figure numbers correspond to two-electrode arrangements and the odd numbers to three-electrode arrangements.

Because so many factors have to be considered in a discussion of the apparent resistivity of mud invaded formations, it is not possible to represent the data with only one chart, as is done for a two-medium distribution.

In non-invaded formations only the factors R, R_m and S_p/d (S_p being the electrode spacing) control the apparent resistivity R_a. In the case of invaded formations, it is necessary to consider also R'_t and D/d. Therefore, full representation of the data requires several groups of charts. These charts give R_a/R_m vs. S_p/d as a function of the following quantities.

Group 1: D/d variable, R'_t/R_m and R/R_m constant. (Figures 16 and 17, which will appear in Part 3.)

Group 2: R'_t/R variable, D/d and R/R_m constant. Six of these charts are given by Figures 8 through 11.

Group 3: R/R_m variable, D/d and R'_t/R_m constant. (Figures 12 and 13.)

To fully represent the data involved, a multitude of charts are necessary. Evidently, if full data are available for any one group, it is possible to use them for establishing any chart belonging to another group by cross-replotting. No new calculations are required. Nevertheless, the total number of fundamental charts is still immensely great. Fortunately, Dr. Alpin has discovered a simple and valuable method for reducing this number appreciably. To better understand how this is being done, analyze quickly a departure curve, for example the three-electrode curve [2, 10, 0.25], the three numbers between brackets representing the curve characteristics, namely, D/d, R'_t/R_m and R/R_m, respectively. This curve is represented as EFGHKL on Figure 14.

Arc to the left. Section EF corresponds to very small spacings. Therefore, its shape is controlled primarily by the mud resistivity, the hole diameter, and the resistivity of the invaded zone. If the degree of invasion is large, the effect of the non-invaded zone is negligible for such small spacings. Arc EF is therefore very similar to the corresponding arc of the departure curve established for a diameter of invasion infinitely large, all other factors remaining the same. This latter case is a two medium problem, the media being:

mud column: diameter d, resistivity R_m; invaded formation: resistivity $R'_t = 10\ R_m$.

The corresponding departure curve E'F'L' is given by Figure 2 (see Part 1 of this series) and it has been redrawn on Figure 15, for convenience. Part of curve EFGHKL has been redrawn on the same figure also to permit comparison between arcs E F and E'F'. In our example, these arcs coincide on only a short length because the assumed depth of invasion is relatively small (d/2). Better match is obtained when the degree of invasion is greater.

Arc to the right. Section K L of the curve of Figure 14 corresponds to large spacings and is therefore little related to the mud column. If the degree of invasion is relatively large, the influence of the mud on this section of the curve is small and arc K L is similar to the corresponding arc of the departure curve established for only two media, namely:

cylinder of resistivity $R'_t = 10\ R_m$, diameter D; non-invaded formation of resistivity $R = 0.25\ R_m$.

The resistivity contrast R/R'_t of these two media equals 0.025.

Intermediate arc. The intermediate section G H of the curve of Figure 14 corresponds to spacings of moderate length. It is therefore related primarily to the invaded zone, namely to the quantities D/d and R'_t/R_m. A discussion of the resistivity of this zone will be offered in the next article.

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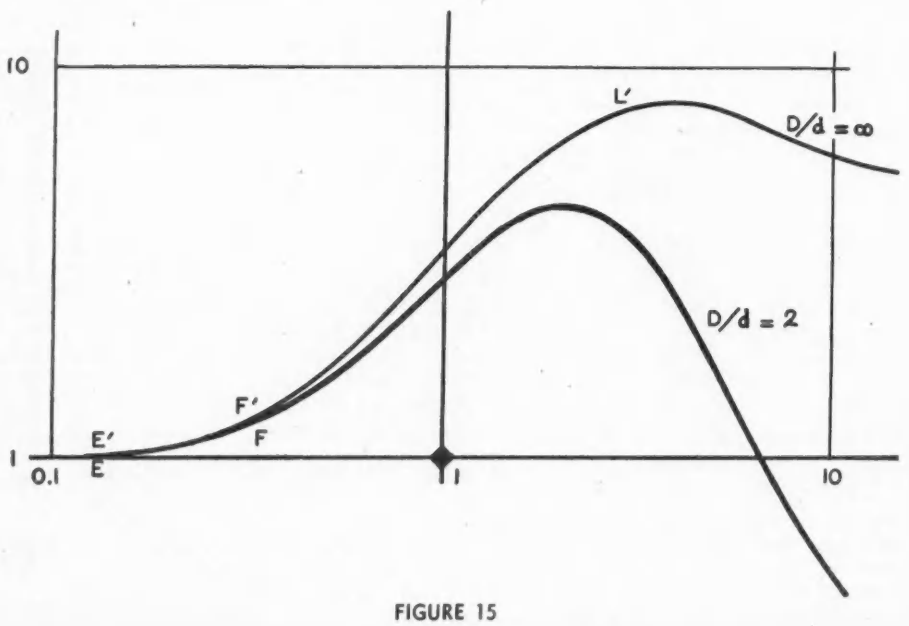

FIGURE 15

Safety Factors in CASING DESIGN

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ANY discussion of the term "factor of safety" requires careful consideration of what it means and how it is applied. For the most elementary design problem, a straight bar under a constant axial tensile load, we know that the stress equals the load divided by the area, or the area equals the load divided by the stress.

In this simple case we see three fundamental factors involved. The first is a knowledge of the magnitude and type of load to be imposed, the second is a knowledge of performance characteristics of the material under the conditions to which they are to be subjected, and the third is a mathematical relation for calculating the area or stress together with a knowledge as to its accuracy under the conditions to which it is applied.

One of the most difficult factors to evaluate in most design problems is that of determining or predicting the loads which are imposed on the structure or member. The practice of the aircraft industry, which uses a low factor of safety, represents one extreme. Their factor of safety is applied not to the normal operation conditions, but to a maximum load several times this, based on the most severe predicted operating conditions. Obviously, if the load to be used in the design of the structure is high enough, a factor of safety of one or even less could be used. This possibility is mentioned to point out that factor of safety alone is no criterion of efficiency, adequacy or reliability of a design.

In addition to the magnitude of the load, it is generally necessary to have information on the type of load and method by which it is applied. Where loads are gradually applied, the maximum value determines the stress condition. Where tensile loads are suddenly applied, the stress theoretically would be twice the calculated values. It also is important to know the nature of periodically varying forces, since if the variation is sufficiently large and there is a large number of changes, fatigue may result.

The second factor, performance characteristics of the materials under the conditions to which they are to be subjected, is likewise indefinite and subject to considerable latitude in selection and application of values. The most serious discrepancy or error which is frequently made in connection with this factor is failure to take into consideration the conditions under which the material is to be used. The use of static properties for fatigue or corrosion fatigue conditions represents one of the most frequent serious errors. A factor of safety of two applied to tensile test data, for example, would be completely inadequate to correct the tensile properties to corrosion fatigue conditions.

THE NECESSITY of keeping oil well costs to a minimum is constantly forcing the petroleum engineer to review his casing design procedures. Unfortunately, there is a tendency among those unfamiliar with the development of casing design procedures to look on it as merely looking into the crystal ball for a factor of safety to fit the pressure of management at the moment. Actually the design of casing strings is on a highly scientific basis. This paper reviews the basis for present practices and to indicate what information the engineer needs to permit keeping the factor of safety, hence well costs, to a safe minimum.

The use of material properties requires further clarification of the actual significance of the values to be used. If factors of safety based on known conditions are to be kept small, it is necessary to use something other than the average properties of the material. Because of the nature of the process of manufacture of materials, each sample tested would be expected to show some variation in characteristics. Chemical specifications have limits that also allow variations in the properties of the material. Two plants operating within the same chemical specifications may produce materials having the same average properties but with different distribution of properties from this average. The distribution of properties around the average depends on the latitude in composition and on the degree of control the manufacturer maintains in the processing of the material. Table 1 lists typical test data on casing. These data show a spread in values typical of materials made in plants where good control is maintained and to meet specifications typical of those used for most structural materials.

The selection of working values from a limited number of tests is a problem (see Table 1). The methods of statistical analysis which are finding widespread use in industry furnish a rational basis for selecting working values. The average value serves as a basis for comparison, but since structures are built to withstand maximum and not minimum or average loads, a minimum value of working strength is necessary. The selection of the minimum value from small samples of a product produced under controlled conditions can be made on the basis of normal distribution from samples. A plot of the yield strength vs percent of values below a given value, on probability paper, for controlled condi-

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tions will be a straight line. Such an analysis of the data given in Table 1 shows that a yield strength of 60,300 lb./in.² is the average or value below which half of the failures will occur. At a yield strength of 55,000 lb./in.,² which is the minimum of the specifications, 3 percent failures will occur. This diminishes rapidly so that for a stress of 53,000 lb./in.² only ½ percent failures would be expected.

On the basis of probability there is no absolute minimum, but if the probability or frequency of failure is set, then a statistical minimum can be established. Where minimums are established, the manufacturer must set up his manufacturing procedures such that the statistical analysis of the test data will show the expected minimum to be within the limits set up. The only alternate to such a system is to actually proof-test each individual piece of product at the minimum loading conditions. This is obviously too expensive for all but the most exacting conditions. The net effect of changing the API practice of using average values to minimum had the effect of reducing the factor of safety by a factor of 1/1.33. A factor of safety of 2 based on average values would correspond to 1.5 based on minimum values.

The third factor influencing factor of safety involves the mathematical relation or its equivalent used for the determining of the proportions of the design to meet the loading conditions. The mathematical formulas used in making design calculations may vary from very precise relations which accurately fit the design conditions, to empirical relations known to apply only generally to the design problem under consideration. In the first case, no allowance need be made in the factor of safety to take care of discrepancy between calculated and realized performance. In cases where no formulas exist or loading conditions are not accurately known so that a formula cannot be developed, a coefficient of ignorance needs to be introduced into the factor of safety to allow for discrepancy between estimated or calculated value and actual performance.

Collapse

The foregoing discussion has considered the general factors involved in a rational determination of factor of safety. The actual factor of safety to be used in casing design will depend on type of loading. Since the three principal features for which casing is designed involve radically different procedures and have entirely different conditions to withstand, they are best handled separately.

The most critical condition in the design of casing strings is collapse. The load conditions imposed on casing insofar as collapse is concerned represent one of the few cases where they can be accurately determined. Since collapse is caused by the fluid pressure on the outside of the pipe, the design is made for the highest pressure differential which may exist, which is with zero inside pressure and a full column of drilling fluid outside the pipe. Since the hydrostatic mud pressure is generally regulated to balance the subsurface pressures to be expected at the depth at which casing is landed, they will in general approach whatever bottom-hole pressure might be expected.

TABLE 1

No. of Tests	Yield Strength	Percent Failures Below Values
1	53,000*	1.17
0	54,000	1.17
1	55,000	2.35
4	56,000	7.07
5	57,000	13.0
5	58,000	18.8
9	59,000	29.4
15	60,000	47.0
16	61,000	66.0
11	62,000	79.0
8	63,000	88.3
3	64,000	91.8
4	65,000	96.5
1	66,000	97.7
1	67,000	99.0
0	68,000	99.0
1	69,000	100.0

Data have been collected for various areas and show normally that the pressure to be withstood is approximately equal to a column of salt water at the depth of the well. However, for some regions such as the Gulf Coast area, these pressures may be considerably higher and may approach in very deep wells, the earth pressures.[1] Except in the case of purely exploratory wells, these pressures will be known sufficiently well beforehand to permit accurate estimating of the load which must be withstood. In this respect, the design of casing strings for collapse differs from other types of design, since normally the load is the one factor about which the least information is available. Another condition under which collapse failure may occur is where earth movements take place. In such cases the forces are generally too large to permit designing for the condition. Where such conditions exist, collapse failures may occur regardless of the factor of safety used. Insofar as the predicted load conditions are concerned, if the pressure, as caused by the mud column is used, no coefficient of ignorance need be included in the factor of safety to cover loading conditions.

The API specifications which cover tubular goods as normally used by the industry now call for minimum performance rating. This means that the designer can use the collapse pressure as set up by the manufacturers as a true minimum value of the strength of the material to be furnished.

The theory of collapse failure has been developed to a high degree of perfection. The work of Clinedinst[2] gives a very accurate correlation between physical properties and collapse pressure within the elastic range. The work of Holmquest and Nadi[3] gives an accurate picture of the mechanism of failure in the plastic range and also gives methods of calculating properties in this range.

Because of the precision with which loads causing collapse, the collapse strength, and the general behavior of pipe under collapse loading are known, it is possible to design casing strings for collapse with factors of safety approaching 1. A factor of safety of 1½ is a very liberal one, and perhaps 1.25 is a conservative value under conditions where all of the factors discussed above are known and controlled. The effect of factor of safety on the overall cost of a well will be discussed later.

As more has become known about collapse and as wells get deeper, the need for economic utilization of materials has resulted in strings of pipe of various grades and weights to meet the conditions under consideration. From the above discussion, it can be seen that where only a column of fluid is on the outside of the pipe, the requirements to resist collapse are reduced from the bottom to the top of the hole. This means that insofar as collapse is concerned, a lighter weight or cheaper grade of pipe could be used. Under these conditions, therefore, there has been a tendency to use this idea in design of casing strings. However, as the casing up the hole carries an increased tension load, the pipe near the top of the well is subjected to both tension and collapse. Some experimental studies have been carried out to determine the effect of combined tensile and collapse conditions and a theory developed which serves as a basis for design. Further study of this problem will be necessary as requirements become more critical and it is desired to push the design to the most economical limit. In designing for such conditions, therefore, the designer must be careful to allow for the more involved loading conditions.

Pullout Strength

As long as wells were shallow, there was no particular difficulty in getting a string of casing which had sufficient tensile strength to support itself. However, as the wells became deeper, the pullout strength of the joints became important, particularly under conditions where lighter weights or lower grades of pipe are used up the hole. Insofar as loads are concerned, there is no difficulty in calculating the static load due to the weight of pipe itself. However, in

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running the casing in the hole, the stresses which are imposed if the slips are suddenly set or if brakes are suddenly applied, can result in shock loads being applied. Also involved in the running of casing strings is the possibility of cavings sticking the string which may require large tensions to free the pipe. In addition to designing for conditions which are to be experienced in the running of the casing string, it is necessary to take into account the conditions which exist during operation. In the case of a gas well, where there is considerable expansion of the gas, the temperature may be lowered sufficiently to introduce further tension after the casing has been set.

The calculation of tensile strength of casing based on rational formulas is impractical. However, a considerable amount of experimental work has been done which has been used as the basis for the development of empirical formulas which give reasonable correlation between calculated and actual pullout strength.[4] Here again, since the manufacturer gives in his tables minimum pullout strength values, the designer has reasonably accurate information on which to base his design.

In the case of design of casing strings for tension or pullout strength, a larger factor of safety than used for collapse is therefore necessary. The major part of this factor of safety is required because the designer does not know accurately the loads which exist as the casing is run in the hole. Since minimum values have been set up for pullout strength, it has been possible to reduce the factor of safety for tension to two and where conditions are accurately controlled, to reduce it below this value. Actually, the value to which the factor of safety can be reduced will depend on the extent to which the designer can depend on the crew in their running of the casing string.

Burst

It has been only recently that the burst strength of a casing has been a factor in its design. This has arisen for conditions where squeeze cementing or high pressure injection in cycling operations is experienced. If excessive squeeze cementing pressures are to be expected, the burst strength should be checked. Barlow's formula has been found to represent reasonably well the bursting strength of the casing strings. Since the maximum pressures which are encountered during squeeze cementing are generally under careful control, it is not necessary to use a very large factor of safety in designing for these conditions. Here again the combination of controlled loading and minimum performance properties permit utilization of factors of safety approaching 1. Where the designer cannot depend on the upper limit of pressures to be carefully watched, the factor of safety must accordingly be increased.

The foregoing has considered the simple elements of casing design. For complex conditions such as where various combinations of loading may result due to gas pressure injected or leakage behind strings, squeeze cementing under special conditions, etc., the analysis of the design becomes more involved. Under such complex conditions the designer must carefully check the type of loading and make a careful stress analysis in addition to estimating the loads to be imposed.

Factors of safety which are now used represent safe minimum values based on current practices. For design of casing strings for normal operating conditions the engineer can rely on experience to indicate trends in practices. The engineer, however, is always looking towards more economical designs. This in general means lower factors of safety. From the discussion given, it appears that the best possibilities in lowering factors of safety will come about through a better knowledge of the loads which must be carried.

Until very recently there has been little attempt to determine the loads which the casing must withstand. One reason for this has been the lack of experimental methods and apparatus and the other is the difficult conditions under which casing is applied. The recent work of Oberg and Masters[5] represents a good start on this problem. Further work of this type is necessary to show the effect of various operating and production practices on loads imposed on casing. Now that experimental methods and equipment are available, additional information should be collected. This information is particularly of help in analysis of difficult design problems. Unless this type of information is made available, the design engineer cannot hope to reduce factors of safety based on actual performance characteristics below present values.

Economic Factors

One interesting factor which arises in connection with design of casing strings is the study of the variation in overall cost of a well with factor of safety. If the data as shown in Table 1 are taken as representative of the strength of the casing as it comes from the mill, one can proceed on the basis of certain simplified assumptions and determine what the actual cost might be, considering that any size and weight which might be desired is available. Actually, of course, variations will be step by step rather than continuously so that there are marked differences which can occur with small changes in factor of safety. These, however, vary with different conditions and the general trend as will be indicated here is perhaps more representative at least in principle of the factors which are involved. The data shown in Table 2, based on the general strength data shown in Table 1, have been worked up on the assumption that failure would be by collapse and if failure occurs the entire investment will be lost. The data given in Table 1 are based on a drilling cost of $60,000 for the well with casing cost arbitrarily assumed for one set of conditions and modified for working stress. The cost of a good well is taken as the cost of a well and casing divided by a factor of one less the percent of failures.

These values listed in Table 2 show that there is relatively little saving to be made by reducing the factor of safety below 1.2. As a factor of safety approaches, or is reduced below 1, the overall cost increases quite rapidly. Table 2 emphasizes that below a certain limit the reduction of cost is small and the probability of failure is increasing.

TABLE 2

Factor of Safety	Working Stress	Percent of Failures	COST		
			Casing	Well and Casing	Good Well
.75	73,000	99.99	21,600	81,600	817,000,000
.80	68,500	99.8	22,000	82,000	41,000,000
.90	61,000	60	22,800	82,800	207,000
1.0	55,000	3	23,600	83,600	86,400
1.2	46,000	....	25,600	85,600	85,800
1.4	40,000	....	27,200	88,200	88,100
1.8	20,000	....	35,600	95,600	95,700

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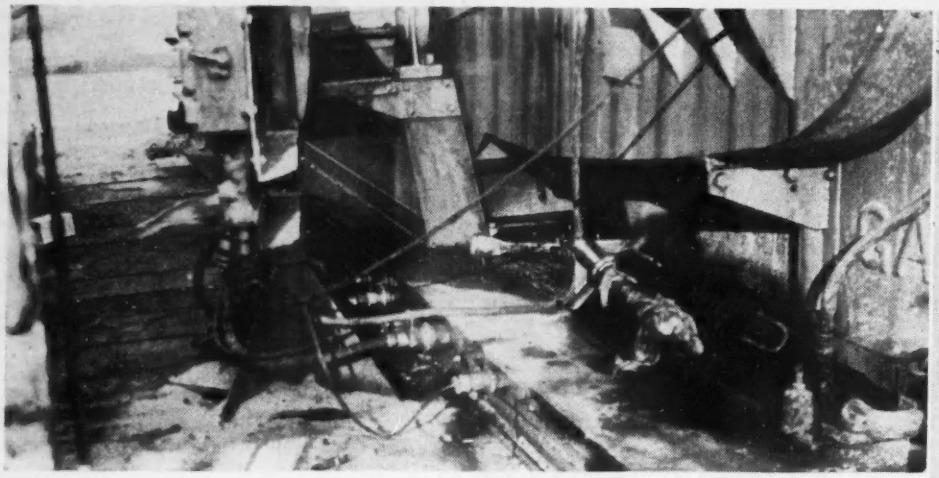

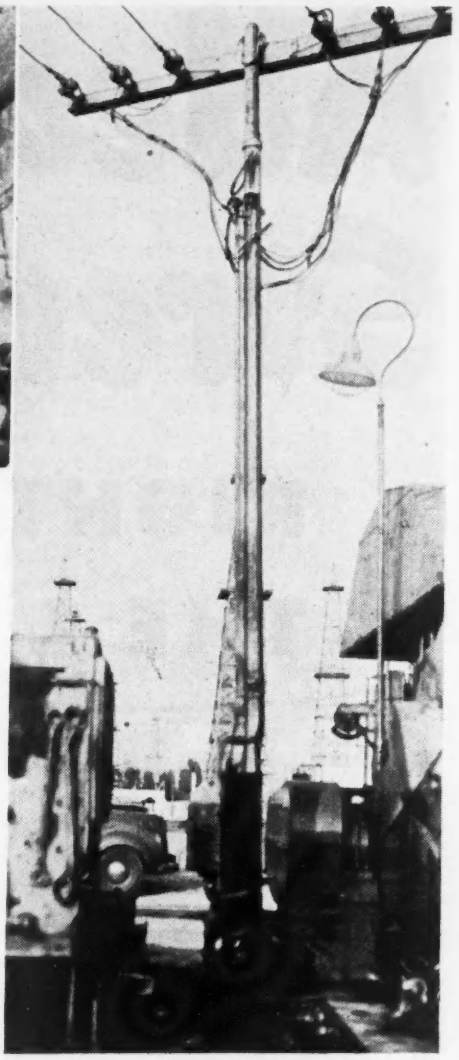

ABOVE: Sockets and connections built into base of pumps and engines so that electrical power can be used by plugging in the lines from the switch boxes on the portable high line post.

RIGHT: Portable high line post equipped with heavy base for bolting to foundation of drilling equipment, so that power may be fed to machinery operated by electric motors and for rig and area lighting.

UNITIZED CONNECTIONS SPEED Rig Power Use

By JOHN C. ALBRIGHT

PROVISION of adequate terminals, switches and the necessary outlets for attaching wiring for electrical service at a drilling well has been found to be a profitable investment by one company.

To obtain the full benefit of service connections, the major units making up the drilling rig are permanently wired for power and lights. Mud pumps, for example, have wiring in conduit attached to the inside channel of the structural steel skid bases, clipped in such a manner as to prevent damage to the wiring and forestall shorts in the individual circuits. This conduit is led from the permanent connection fixtures to the various parts of the unit where lighting equipment may be needed and where power may be obtained for small motors. On practically all drilling rigs, two mud pumps are used. One is the "master pump," being that unit which is fitted with connections for reception of current for the remainder of the pumping equipment. Service connections are installed at convenient points on the "master pump" so that plug-in connections may be made to carry power to adjacent units through flexible couplings or through wires in metallic conduit.

Other units have only a single plug-in receptacle from which light and power wiring, also in conduit, is led to the various points where lighting fixtures may be required. Conduit wiring on all units, including the drilling rig and additional auxiliary equipment, shale shakers, air compressors and the like has permanent installations fitted for plug connections so that rigging up requires only the approved plug connections and the necessary leads.

The high-line pole on the drilling rig is a shop-made metal post with a heavy flanged base, reinforced with gusset plates or buttresses to stiffen the installation. The heavy plate on the bottom of the post is set squarely upon the planking which forms the temporary mat, or on the concrete pad around the well. Holes in the heavy plate allow for the use of lag screws to secure the post to the wood foundation so that tipping or weaving is eliminated. The top of the high-line terminal post is equipped with cross-arm carrying insulators on the side to which the leads are attached which conduct the power from the transformers on the electric company's distribution system, or from wiring which carries the current at the voltage normally used for rig lighting and power requirements.

Wiring from the cross-arms is conducted to the base of the post through conduit from which the various circuits are led to switches and junction boxes for distribution to the master pump. Spark-proof plug connections are permanently attached to the outlet boxes and switch cases, requiring only comparatively short leads to the permanent connections on the side of the pump foundation. On all locations the high-line post is set as close to the master pump as possible so that the designed leads may be used without improvising new leads when rigging up. Having a post of this type provides a uniform system of wiring and permits leads from the transformer bank to the rig to be of a height sufficient so that trucks and men working beneath will not disturb the circuits, nor will the overhead wiring interfere with any work necessary.

Part 2

Drilling Deeper Wells

PROGRESS of the *Drilling Industry*

Photo courtesy Humble Oil & Refining Company

by

C. W. ALCORN

IT IS the opinion of many that little oil will be discovered in commercial quantities below 15,000 feet, and some companies are not spending much time worrying about it. With a few exceptions, production encountered below 12,000 feet has been gas with various amounts of distillate, and the deeper the wells, the less distillate recovered with the gas.

It is the writer's opinion, however, that if oil and gas are discovered in commercial quantities below 15,000 feet, and regular drilling programs are carried on to those depths, they will be successful. Both the operators and equipment manufacturers will meet the challenge as well as they have met the challenge of increasing depths since the beginning of commercial oil production in the U. S.

In 1939, the first contract was made to drill a well to 12,000 feet. An account of the drilling operation appeared in the trade journals. From the account, it looked easy and actually was, except for a few qualms. The work was planned from experience and went off according to plan. A recent article in the trade journals concerning The Superior Oil Company of California's 17,823-foot hole in Caddo County, Oklahoma, is impressive in its account of the performance of equipment and the ease with which the record was accomplished. This record does not depreciate the great effort that was placed on the planning of this work from day to day, but it is proof that methods employed in drilling a well afford great latitude to the operator to apply judgment and experience. The know-how developed through experience and the general good judgment of successful men in the drilling industry, make a seemingly impossible task appear almost easy when the job is finished. This Superior well is almost 33⅓ percent deeper than the 12,000-foot well mentioned above, and experience gained in equipment and technique since 1939 made their job almost as easy for them as was the 12,000-foot well.

Deep Drilling Requirements

In 1944, a major company made a study of drilling equipment and technique and compiled a list of principal equipment needed for 15,000-foot drilling.

"On the basis of a special study and recent observations in the Louisiana Division of the operation and performance of the individual items of equipment that are now used on our heaviest drilling rigs, the following recommendations can be made as to size and type of equipment that will be needed to drill to a depth of 15,000 feet. In making these recommendations we have in mind that manufacturers will have a need for factual information of this kind in designing equipment for postwar deep drilling operations and that they will use their ingenuity in developing and simplifying equipment to the end that we can drill wells faster and with a minimum of effort on the part of the drilling and transportation crews."

Derricks: "The API load capacity should be 800,000 pounds, and for handling 90-foot stands of drill pipe, the derrick should be 136 feet high and have a 30-foot base. In the event equipment is developed that would make it practical to conveniently handle a longer stand than 90 feet and drilling conditions necessitate making a considerable number of round trips, then consideration should be given to the use of a taller derrick (178 feet high by 32-foot base) as a means of reducing the time now required to make a round trip. Consideration should be given to the development of a practical safety device that conceivably would be used as an operating device to prevent bumping the crown block with the traveling block."

Derrick substructure: "To be of the truss type which carries all interior loads direct to the corner columns. Height of the substructure measured to the bottom of the floor joists should be ten feet and the base size should correspond to that of the derrick. Substructure corner columns should have a combined API load capacity of 1½ million pounds. The trusses supporting the rotary table should be capable of sustaining a casing load of 450,000 pounds a 33⅓ percent impact load or a static working load of 600,000 pounds. Provision should be made for a drill pipe setback load of 300,000 pounds with the

pipe racked either by the 'monkey-board' or 'hay-rake' methods. The interior bracing should be arranged to provide a maximum of unobstructed working space at the cellar and permit installing the conventional kelly rathole on either the ramp or pump sides and two additional ratholes, one located in front of the draw-works drum for the accommodation of a stand of drill collars and the other adjacent to the rotary table for use in making a drill pipe connection."

Crown block: "The safe working load capacity should be 350 tons and sheave diameter should be as large as practical in order to prolong the life of wire rope. Extremely heavy wire-line loads will necessitate giving more attention to the fleet angle between crown and traveling blocks in order to avoid undue side thrust and consequent early failure of the blocks and wire line from this cause. Consideration should be given the matter of conveniently raising the block and landing it on the water-table header beams."

Traveling block: "The safe working load capacity should be 300 tons with sheaves and bearings being interchangeable with those of the mating crown block. Attention should be given to maintaining close sheave centers so that the overall width of the block will be as narrow as it is practical to obtain."

Wire rope: "Attention is called to the need of a stronger rope than the best grade drilling rope now available in the 1¼-inch size to handle the loads that will be encountered in 15,000-foot drilling operations if the number of lines on the blocks is to be held within practical limits. It is felt that this is a matter that justifies serious consideration on the part of wire rope manufacturers as well as the manufacturers of hoisting equipment." (1⅜ and 1½ inches are now available from rope manufacturers.)

Drilling hook: "To have a safe working load capacity of 300 tons."

Drill pipe elevators: "Safe working load capacity of 200 tons. Elevators should be of the center-latch type which support the load on a 90-degree shoulder or 18-degree taper. Consideration should be given to keeping the weight of this item as low as possible, to facilitate ease of operation."

Casing elevators: "To have a safe working load capacity of 300 tons. Elevators of this capacity will be of the slip-type to handle oil strings and long protection or intermediate strings. In designing this item of equipment every effort should be made to reduce its bulk and weight because the available equipment is objectionable from this standpoint and its use results in costly delay."

Casing spiders: "Safe working load capacity of 300 tons. This item of equipment will probably have a wider application than in the past and attention should be given to ease of operation by the use of a power operated slip mechanism."

Swivel: "Safe working load capacity of 200 tons at a speed of 150 revolutions per minute. Higher pump pressures, as a result of compounding pumps, require that attention be given to the wash-pipe stuffing box and packing to prevent excessive leakage and downtime due to this cause. With the higher rates of circulation, the use of a four-inch wash pipe is desirable but not yet practical, and every effort should be made to develop a suitable packing assembly for this size."

Rotary hose: "Only Class C, or better, hose should be used. Attention should be directed to the development of a rubber hose having a bore that is more nearly equal to that of 4½-inch OD, 16.60-pound drill pipe."

Drill pipe: "To be 4½ inches OD, 16.60-pound internal flush, or five inches OD, 18.50-pound external-internal upset of API Grade E or higher strength material. Pipe to be Range two if used in a 136-foot derrick and Range three if the use of a 178-foot derrick proves desirable."

Tool joints: "API 4½-inch by 6¼-inch OD internal flush with a tool point pin on both ends of the pipe and a double-Double-box sub to be flame hardened to 52 to 58 Rockwell C with a ⅜-inch depth of flame hardening."

Drill collars: "Until improved drill collar joints are developed, the size and type of joint to be used with different diameter drill collars should be in accordance with the present standard. Consideration should be given the matter of providing a satisfactory protective metal coating for the shoulders and threads of new drill collar joints and subs to prevent galling of the mating surfaces."

Drag Bit Design

Bits: "To reduce pump pressures and increase the rate of circulation, 8⅝-inch and larger bits should have four 1⅛-inch diameter water courses, or water courses having equivalent flow characteristics. The use of bits with four 1⅛-inch diameter water courses on a test rig as compared with four smaller diameter water courses showed that there was less tendency for the larger size water courses to cut out or plug. The material and design of drag bits should be investigated with a view to obtaining a bit with a much thinner blade that will cut with less weight on the bit and remain sharp longer. Special attention should also be given to providing a reaming edge that will stay to gauge better than that of present day bits. There is a very urgent need for a better type of bit for drilling chert, and at the present time diamond bits are being tried in this type of formation."

Drawworks Engine: "Should be capable of developing approximately 1500 horsepower at the rated maximum operating speed of the engines and 350 pounds boiler pressure." (A 16 x 16-inch for 350-pound steam and 15 x 16-inch for 500-pound steam, now available, will meet this requirement.)

Drawworks: "To be of a size and type that will handle a load of 200 tons when hoisting drill pipe and 300 tons when running casing. It should be capable of transmitting the maximum delivered horsepower of the engine. Considerable thought should be given to the improvement of this item of equipment because the present drawworks during its lifetime consumes supplies such as wire rope, sprockets, chain and brake bands that cost several times the original cost of the drawworks. Although not yet available, it is desirable to have a drum large enough to accommodate all of the hoisting rope onto one layer, and consideration should be given to the use of a gear transmission in place of sprockets and chain. For ease of operation, it is essential that the drawworks have a much improved brake system that does not require the use of an auxiliary hydraulic brake and all clutches should be designed for air or hydraulic operation. Consideration also should be given the matter of a suitable automatic feed control. A drawworks embodying all of the above features would be a much improved and desirable item of equipment for deep drilling."

Rotary table: "Approximately 250 horsepower should be provided for driving the rotary table. Attention should be given to providing a much better means of sealing the rotary table to prevent entry of mud and wash water and the consequent early failure of bearings and gears. The main table bearing of the present rotary has to support all of the pipe load when the pipe is set on the slips, and to prevent damage of the bearing from this cause, provision should be made to support the pipe by some other means. To reduce the physical effort in making round trips and thereby speeding operations, it is considered essential that we give considerable thought to the feasibility of developing a rotary-table unit that embodies power-operated equipment for performing the various operations incidental to making-up and breaking-out drill pipe, which is discussed as auxiliary equipment under the next two subheadings."

Power-operated casing and drill pipe slips: "These items of equipment are now in the course of development and their use as a means of improving working

conditions on the rig should be investigated as soon as the equipment is available."

Equipment for making up, breaking out and racking drill pipe: "There is a very urgent need for automatic or power-operated equipment for such operations as stabbing, making up, breaking out and racking drill pipe to prevent much of the fatigue of the drilling crews as a result of the heavy work entailed in making a round trip. The use of such equipment when available will undoubtedly result in greatly reducing the overall time required to drill deeper wells. The physical effort required in making up pipe is reduced to some extent when using a make-and-break rotary; however, high maintenance cost of the present make-and-break rotary as a result of insufficient lubrication of all working parts and the difficulty of preventing contamination of such parts with mud and other foreign matter do not permit its general use."

Core reel unit: "To have a line pull capacity at least equal to the breaking strength of ⅝-inch 6 x 19 improved plow steel rope and a spool capacity of 18,000 feet of ⅝-inch line. Input horsepower to the reel should be approximately 300. The unit should have a line spooling device and be capable of a line speed considerably in excess of that of the present units. Consideration should be given the matter of portability and an improved water-cooled brake system should be developed that will permit feeding off the line at the maximum rate without undue physical effort on the part of the operator."

Boilers: "To be of the 150-horsepower class and suitable for 350 pound steam working pressure. The required draft will be maintained by the use of a stack-blower system using exhaust steam from the rig, or live steam when there is insufficient exhaust steam available. It will be necessary to have four boilers on the line and therefore a fifth boiler should be available if one of the boilers is to be out of service most of the time because of bad water or other causes."

Steam line: "A six-inch steam line should be used from the boilers to the rig in order to reduce the pressure drop. In changing from a four-inch to a six-inch line on a test rig, the pressure drop was reduced from 70 to ten pounds, and when drilling at 9000 feet, the 60-pound higher steam pressure at the pump and a ten-pound lower back pressure in the exhaust steam system resulted in an increase in mud circulation rate of 22 percent."

Slush pumps: "Three duplex pumps, each capable of delivering approximately 400 hydraulic horsepower, should be available with provision made for operating any two of the three pumps in parallel or series. A fourth pump of a smaller size should be provided for mixing mud. It is particularly important that attention be given to the improvement of the fluid-end stuffing box and lubrication of the rod packing to overcome the tendency of the rods being badly scored, and rapidly cut out as a result of the higher pressures when operating two pumps in series. Pump suction flanges should be of the quick-change-union type which must be suitable for the higher pump suction pressures that result when operating the pumps in series."

Blowout preventers: "This equipment should be of the quick-ram-change type to eliminate the delay entailed in changing the rams of the type now in use."

Well-surveying instruments: "In selecting well-surveying instruments, it is, of course, essential to consider their accuracy and dependability; however, consideration should also be given to the amount of rig time involved in the use of the various types.

"It is apparent from the above that 15,000-foot drilling operations will require the use of equipment that is capable of handling extreme loads and that can be operated with a minimum of physical effort on the part of the drilling crews. Although much equipment of the size needed is now available or in the process of development, it will require the cooperative effort of both manufacturers and operators to develop more suitable equipment and devise means whereby working conditions incidental to the transportation, setting up and operation of a rig that will successfully drill to 15,000 feet will be improved and drilling cost be reduced as a result of being able to complete wells in less time."

Since 1944, much of the equipment suggested in this outline has been perfected through experiment and is now available from manufacturers.

Status of the Drilling Industry

The increasing demand for petroleum products will require more and more completed wells in order for the industry to meet the public need. Eighty percent of the holes drilled in the U. S. are drilled by contractors, and it is imperative that the drilling industry keep on a high plane of efficiency and progress in order to keep pace. This will not be done unless the business is kept on a fair profitable basis. During the war, contracting profits proved to be high and in some cases, possibly too high. On the other hand, the industry generally was in a state of obsolescence and a high percent of profits generated during the war went into better and more efficient equipment. The drilling industry in the U. S. is in better condition today from the standpoint of modern and efficient equipment than at any other time in its history. If this were not so, drilling prices would have to be much higher than now to meet increased cost of labor and supplies.

A contractor with all rigs confined to one area reports the following comparison from January 1, 1943, throughout first five months of 1947, on his business.

Year	Average
1943	6040
1944	7180
1945	7190
1946	7540
1947	7450

1. Rate of penetration 51 percent increase attributed to:
   A. more efficient equipment,
   B. heavy weight drilling,
   C. greater crew efficiency.

2. Increased cost in all operating items plus increased daily costs due to increased rate of penetration 33 percent increase.

3. Revenue per foot of hole, 6 percent decrease.

The following data shows that the supply industry is equal to the demand for new drilling rigs and is probably able to over-supply it. On August 31, 1945, 1792 rigs were actually drilling, 393 rigs temporarily shut down, and 355 rigs stacked. On August 31, 1946, 1658 rigs were actually drilling, 489 rigs temporarily shut down, and 532 rigs stacked. On August 31, 1947, 2035 rigs were actually drilling, 420 rigs temporarily shut down, and 540 rigs stacked. These figures show an increase of 455 rigs between August 31, 1945, and August 31, 1947. These are presumably new rigs supplied to the industry in that length of time. Note also that there were 532 rigs stacked in 1946 and 540 rigs stacked in 1947. This latter indicated a definite over-supply of drilling rigs, when in that same period, the number of rigs actually drilling increased 377.

Conclusion

The drilling equipment industry and the drilling industry in general has developed with the needs and the demands of the business for more petroleum production. While drilling to depths of 18,000 and 20,000 feet looks very difficult, it is predicted that if someone finds production that can profitably be produced from those depths, the industry will drill the wells and never look back.

Acknowledgment

The writer gratefully acknowledges the data and material so generously furnished by the various equipment manufacturers, oil companies and drilling contractors. The data on drilling bit progress supplied by Hughes Tool Company is especially appreciated. For permission to reproduce Humble Oil & Refining Company research data the writer is deeply grateful.

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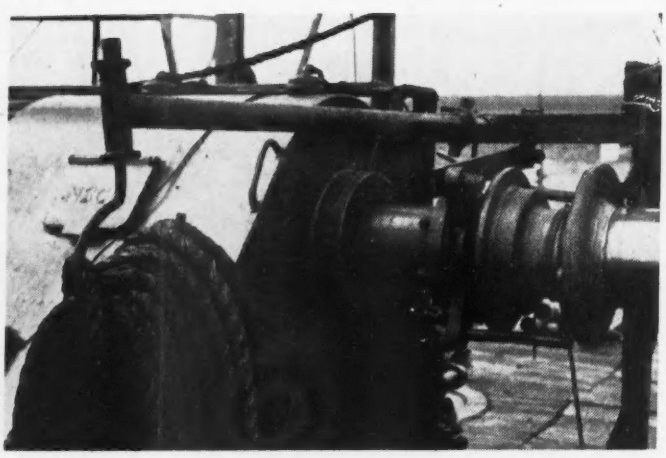
How To— Support Catline and Reduce Stumbling Hazard at Drawworks

The necessity of maintaining a clear floor on the drilling rig has long been recognized and there have appeared throughout the industry ingenious means for accomplishing this end. One of the most prevalent hazards introduced in the way of cluttered-up derrick floors is that provided by uncoiled catlines resting on the floor near the drawworks. This situation has been minimized on one rotary rig through the utilization of a hook extension on which the catline was supported as illustrated.



The extension was anchored to the head beam of the drawworks on which was welded a 2½-inch pipe collar. A short pipe nipple was screwed into this collar and carried a hammer-type union on the opposite end. A four-foot extension of the same size pipe was then connected to the union. To the open end of the extension was welded a short nipple forming a "T" head. Both ends of the head were capped with boiler plate steel through which was cut two ¾-inch holes. The shank of the catline hook, made from sucker rod material, extended through the "T" head and was held in place by two nuts which formed a locked cap.

The hook was free to rotate, but was held in a firm upright position. Swivelling action permitted the line to be jerked clear when placed into service, or to permit easy coiling of the line when not in use. When the rig is to be moved, the hook and its extension are disassembled by breaking the union, leaving the short stub on the head beam where it remains during the move.

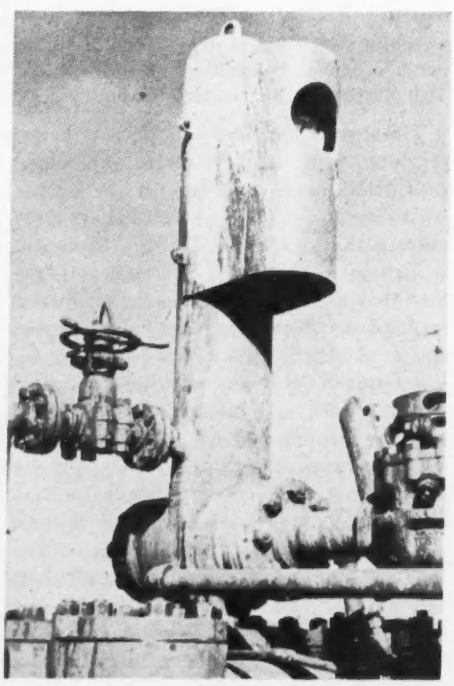
Such a device keeps the derrick floor clear of the catline and provides a method of storing the line.

How To—Protect Mud Pump Pressure Gauges on Permanent Installations

Pressure gauges and other pieces of equipment in the instrument class are costly items and are those most easily damaged through rough treatment and abuse common to drilling operations. During rig moves, this type of equipment requires special handling and care to insure its proper operation on the next job.

Ample protection for the mud pressure gauge has resulted from one unique method of shielding and thereby making it possible to leave the gauge installed on the mud pump discharge permanently. The method of shielding is illustrated, in which case the pressure gauge has been mounted on the mud pump surge chamber.

The shield is merely a covering of steel plate of proper size and design to fit on the chamber. Four small metal "ears" were welded to the surge chamber to form a means of anchoring the shield to the pump. A section of pipe



is cut long enough to sufficiently cover the entire length of the gauge, and is of the same diameter as that of the surge chamber. The pipe thus cut is split down the longitudinal axis making two pieces. Only one piece is used, and in this piece is cut a circular opening to provide a peep hole so the gauge face may be seen once covered with the shield.

Two rectangular pieces of sheet steel cut to the same length as the half-section of pipe are welded to the curved piece as shown. Two sheet steel "ears" are welded to the edges of each piece to match the ears spotted on the surge chamber. The shield is then bolted in place over the gauge with sufficient space between it and the gauge to provide adequate protection against heavy blows during rig moves or other operations. Life and accuracy of pressure gauges are thus insured, and the time and trouble of dismantling these parts are eliminated.

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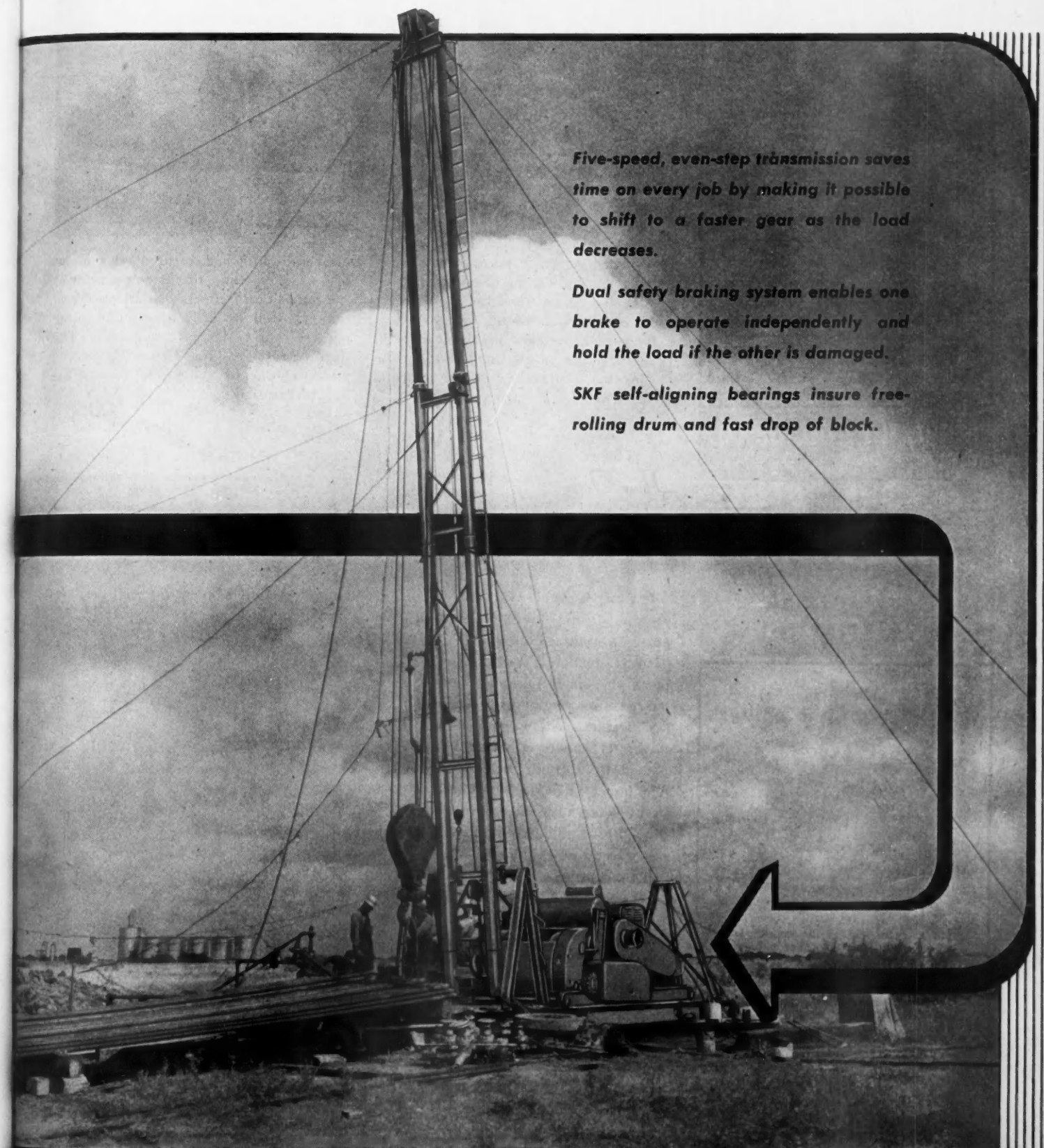

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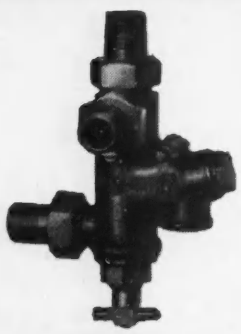

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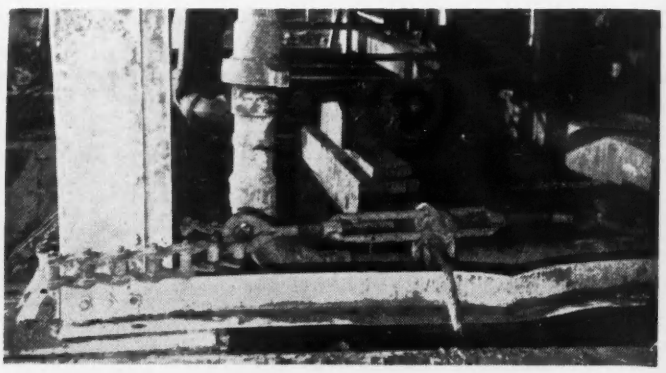
How To — Anchor Mud Lines to Prevent Pounding



Pump pound in mud lines to the standpipe may be checked by fastening the line to the derrick legs where it enters the substructure and where it turns upward into the standpipe. These two anchors are formed from heavy 1½-inch turnbuckles, the eye end linked to a section of drilling chain taken once around the derrick leg, the hook engaged in an eye welded to the mud line so that the weld will be in tension.

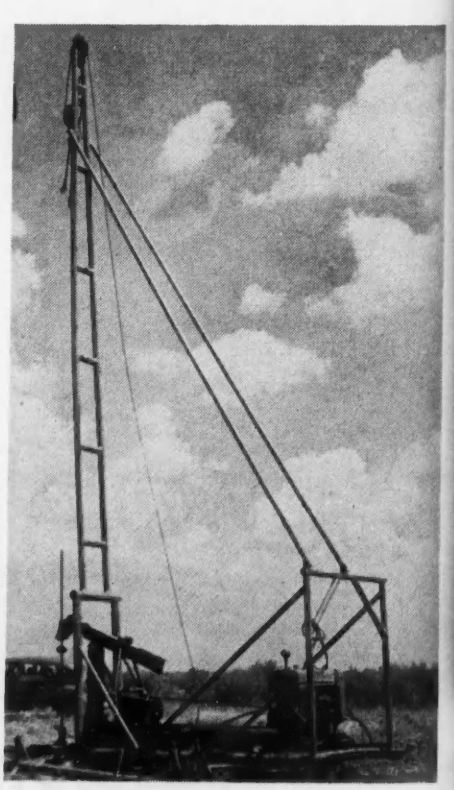
By setting up on both turnbuckles (one of which is shown), that portion of the line under the derrick is firmly secured against lengthwise shift, but is not rigidly attached to the derrick members. This method of fastening relieves the mud line of effects of derrick vibration, as well as preventing mud-pump pound from reaching the derrick. The turnbuckles are kept from slackening under service by tying one side of the nut to the pipe.

How To — Fabricate Water Well Pumping and Servicing Unit

If water is obtained from wells to supply the drilling rig for operating purposes, a unitized pumping rig can be used to advantage. A skid type base supports the small pumping unit and the gas/gasoline engine used for power. An "A" frame mast, which may be folded down, is supported with braces connected to a frame behind the engine. The unit may be used only for pumping, or by some adjustment can also be employed for pulling rods and tubing when the water well required a work-over.

The skid was fabricated from four-inch pipe material as was the upright braces forming a "U" over the pumping unit. Upper leg sections of the "A" frame mast and the rear lay-down supports were made from three-inch piping. The unit is all-welded with the feet of the mast strapped around the inverted "U" base support. This design makes it possible to fold the mast down into a horizontal position for moving.

Convenience and time-saving are outstanding features of this unitized water well rig. Relatively little time is required to pull equipment from the well preparatory to a rig move.



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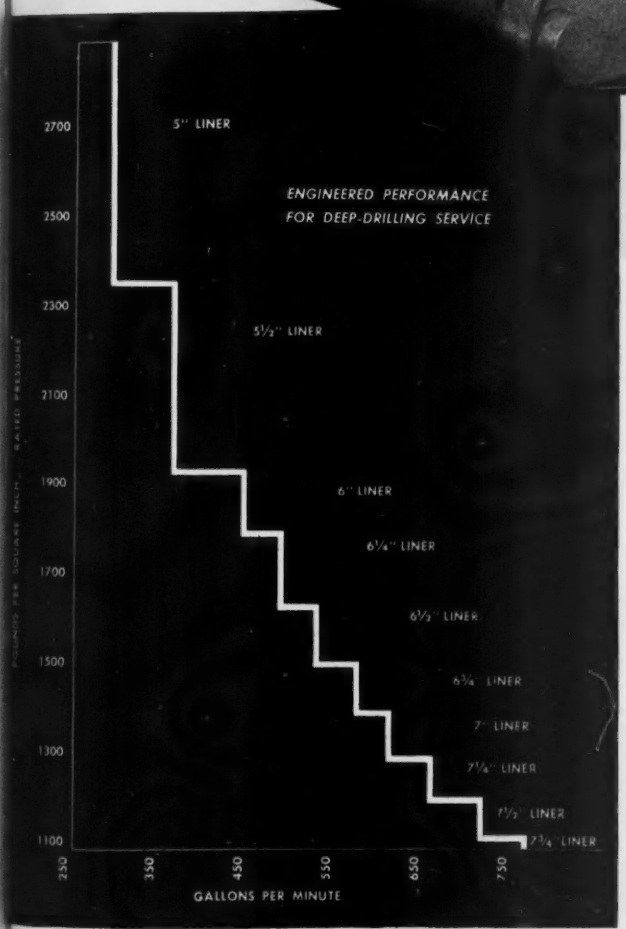

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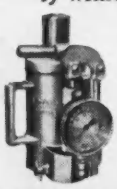

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How To—De-Gas Drilling Fluids

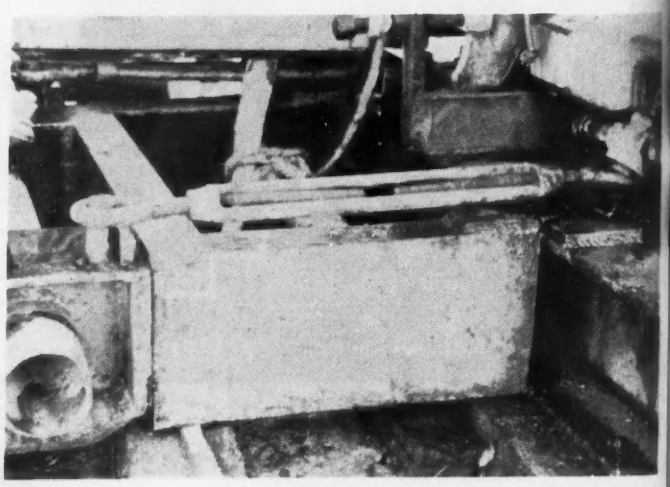
Gas-impregnated mud can be cleared quickly by pumping it from the mud tank over a series of flumes similar to a narrow stairway. Two-by-twelves are cut and placed in a frame as if they were treads and risers and installed at an angle of 45 degrees so the risers are vertical, and the treads horizontal. Supported by a timber structure, of necessity only a temporary unit, mud is pumped into a box receiver at the top, and gravity does the rest of the job.

As the fluid overflows from one step or flume to another, it is aerated to permit the entrained gas to escape into the atmosphere. The degree of gas impregnation will usually determine the number of steps required. In cases where only a slight amount of gas has been trapped in the mud, only a few flumes need be used. A second mud receiver box is located at the foot of the flume. From here the mud is piped into the mud sump pit where it is picked up and recirculated through the mud system. Not only does this flume provide a simple and inexpensive means of removing trapped gas, but it will also take out minute particles of sand.

How To—Maintain Engine-Pump Alignment

To keep the mud pump and engine in correct alignment without distortion or slipping, a heavy box-type distance piece may be provided. The distance piece is made by using channel iron, wide enough to reach from one skid member to the other on the mud pump. Wedge type blocks are welded to each side of the distance piece to fit in vee-shaped grooves on the wide flange steel skid member beneath the engine nearest the pump. Pins welded to the skid members of both the pump and engine form anchors for two turnbuckles employed to pull the two units tightly together.

Not only does this method simplify alignment of the two pieces of equipment, but it also joins the two units together as though they were mounted on one framework. Use of the turnbuckles eases the job of pulling the two units up to proper position and holds them in this position so that tension in the vee belts is maintained. This construction eliminates additional framework which might perform the same function, but would add to the overall dimensions of one unit when dismantled for moving.



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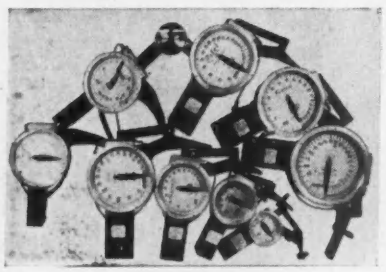
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How To—

Protect Wire Rope on Dead Line Anchor

Passing a loop of the dead line around the bottom sill of the substructure relieves any portion of the derrick of tension load from the drilling line, and places the entire dead-line side of the structure under compression.

Use of a bent section of heavy pipe as guard for the line where it bears against the sill prevents sharp kinking at the corners of the timber. It also distributes the load over the entire sill, instead of overloading the edges. A closed pipe tends to collect mud and water as the rig is hosed down, sometimes exposing the anchor section to rust or leaching of the lubricant before the line is shifted to another section.

One company retains the good points of the pipe guard, yet overcomes its disadvantages. A short piece of heavy pipe is equipped with heavy welding ells on the ends, being formed to fit snugly on the standard timber sill. The outer portions of the welding ells are then slotted to give clearance for the line, and to provide drainage through which will flow any fluid intercepted by the ells.

The fitting is threaded onto the line, held in place with a jack, block or wedge below the sill, and the line cleared through the notches. The line shifts easily through the smooth ells, equalizing the load on both parts to avoid overloading any strands of the wire.

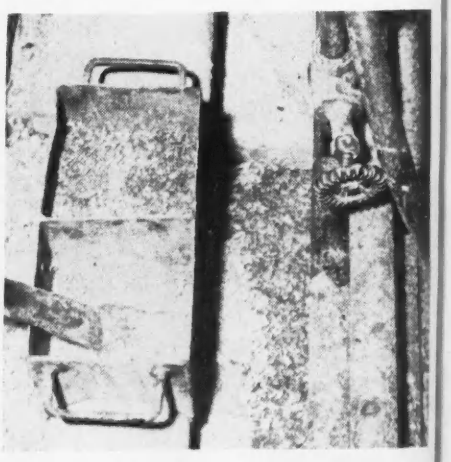
How To—

Dry Well Cuttings in Sample Dryer

Heat from the steam line near the derrick is used to dry cuttings so they may be sent to the laboratory. A box or "rider" of light sheet metal is made to a width just under the O. D. of the steam line. The two ends and center partition are cut with the torch to fit closely on the line, with the sides beveled to form a tight joint also.

The box is placed over the steam line, and cuttings put directly on the steam line. As they dry they are turned with a small paddle, which is also used to dip them up for sacking. The central partition provides for drying two lots of cuttings at the same time without mixing. The unused cuttings are removed from the box simply by lifting it clear of the steam line, thus permitting the fine material to slide off the pipe and leave it clean for the next batch.

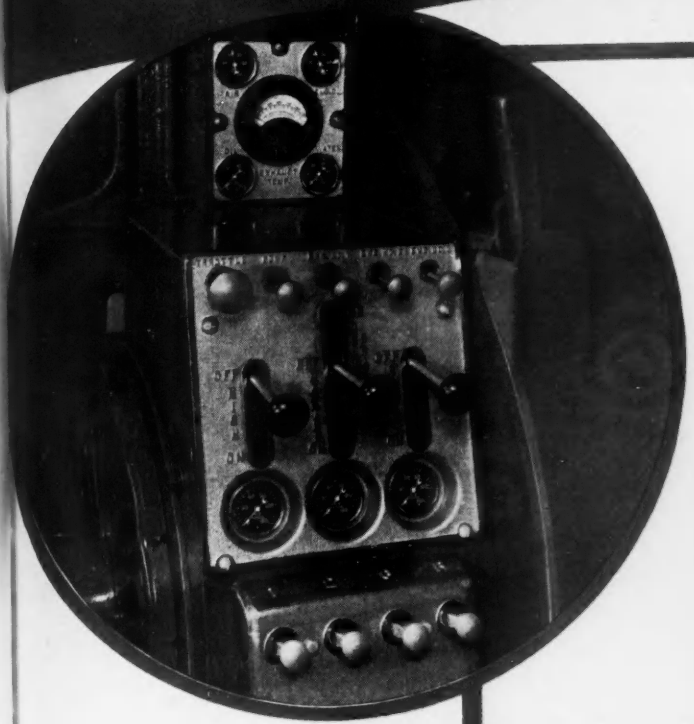
When cuttings must be dried in wet weather a small piece of corrugated iron,

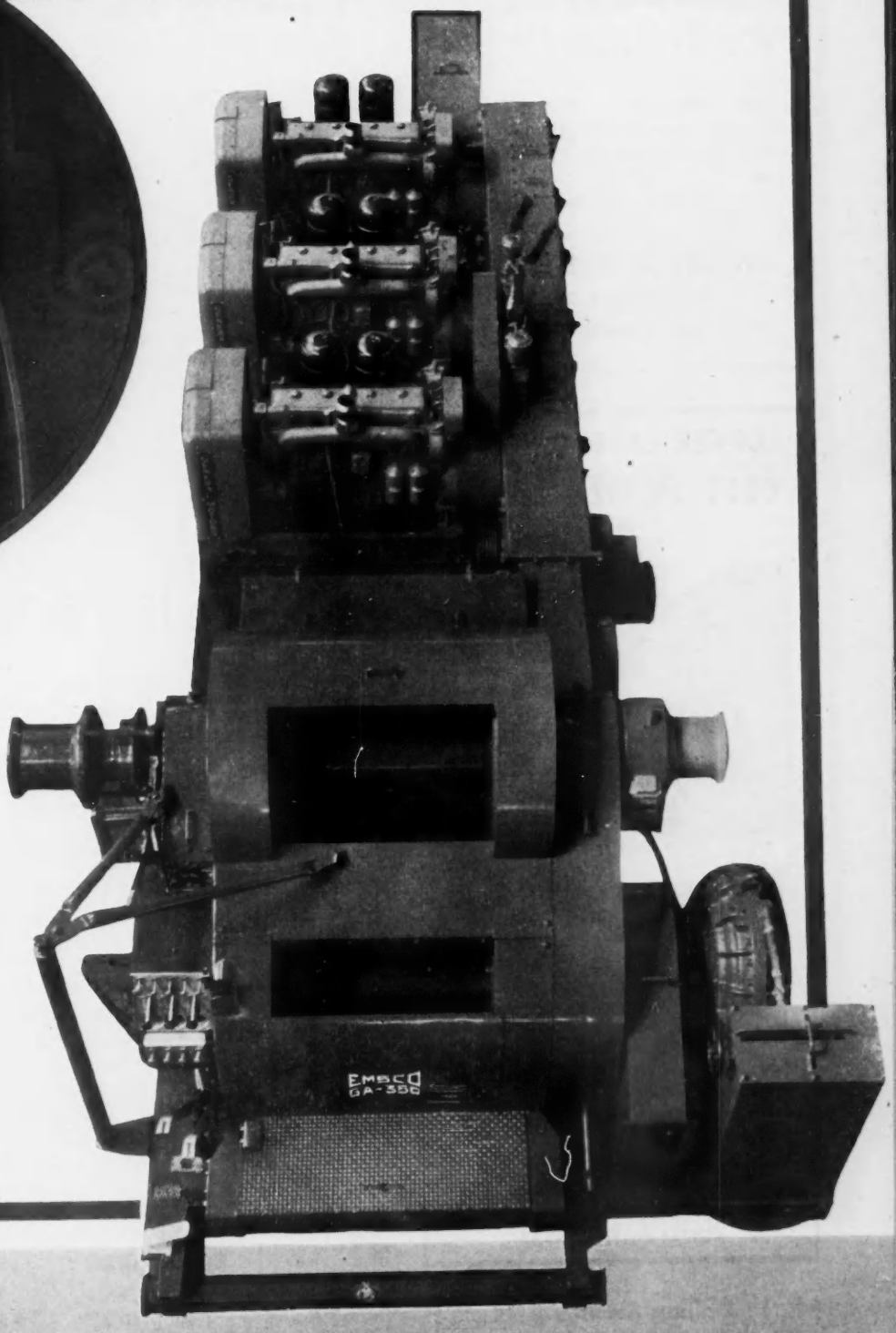


large enough to overhang the box on all four sides, is used as roof. The corrugations provide an area for the escape of moisture driven from the cuttings, and at the same time carry the drip clear of the steam line at the box location.

GA-350

DRILLING RIG





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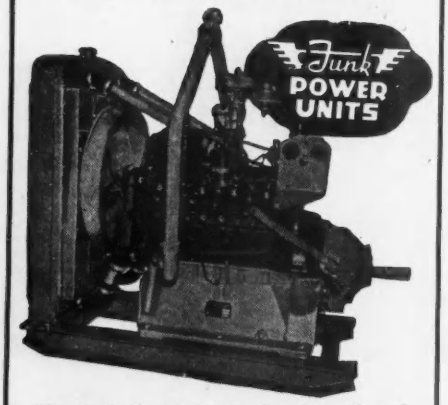

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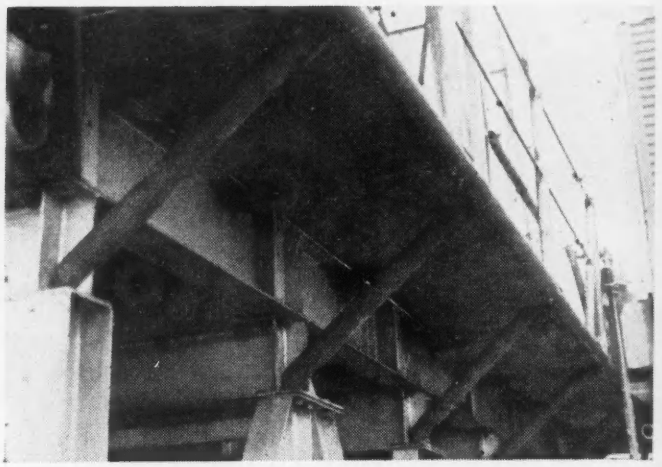
How To—

Adapt Rotary Chain Links to Hinges for Catwalk



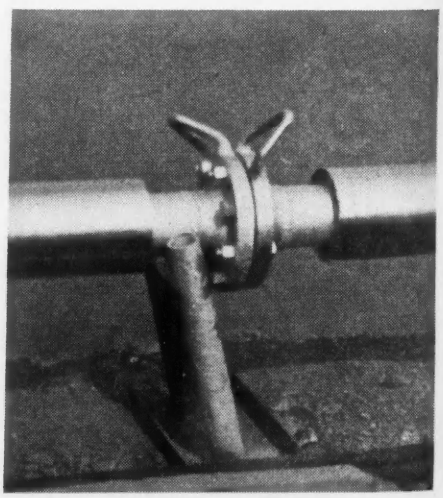
The varied uses to which discarded rotary chain is put around the average drilling rig are too numerous to mention, but one of the more ingenious applications may be found in the elevated collapsible flooring on the rig of a West Texas operator. In this installation, a sheet metal walkway surrounding the power unit section of the rig is made to collapse, dropping down to the side of the substructure, simplifying tearing down and trucking operations. Hinges for the walkway were made of two-link sections of the chain, each half being welded to its respective side of the collapsing section. Lengths of three-inch pipe secured with bolts at each end support the walk in the erect position and are pinned so as to swing free when the walk is to be lowered. The chain links provide exceptionally sturdy hinges for this type of service, may be lubricated readily if necessary and are easily installed.

How To—

Handle Steam Lines for Quick Installation

Steam lines can be placed in position for coupling with a minimum amount of time and with less labor when each joint is supplied with loops welded to the flanges. The line illustrated is in service on multiple drilling sites where down time is an important factor to be considered. The line is made up in 25-foot sections, fitted with welding flanges with matching bolt holes so the handling loops will always be at the top to attach the sling of a rigging crane. This method of handling steam lines not only facilitates their movement from one location to another, but it also adds materially to the life of the insulation covering. If the line is accidentally dropped on the ground, the flange ends will protect the asbestos covering.

Prefabricated line supports placed at each joint provide adequate bracing for the steam line. These supports are made from a short section of 10-inch channel iron, two upright pieces of 2½-inch piping and a cross brace of piping. The flat surface of the channel iron maintains an upright position of the supports while the steam lines are lowered in place. They are sturdy and can be easily handled by one man.



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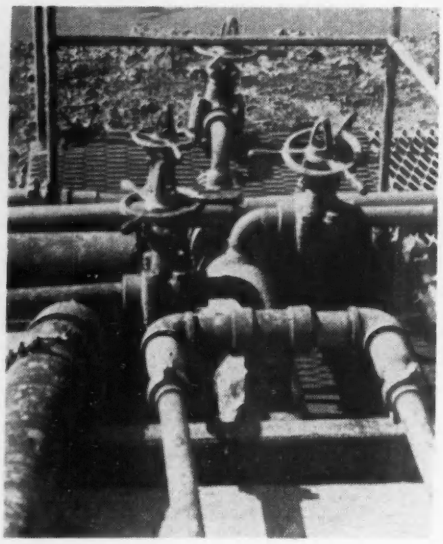
How To—

Manifold Mud Lines For Quick Changeover

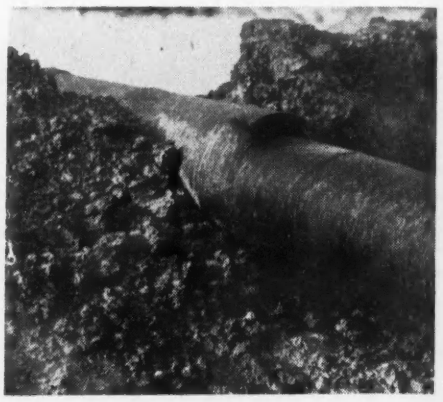


When formations change abruptly, a corresponding change of drilling mud is frequently necessary and the change sometimes cannot be made too quickly. In order that rapid disposal of the mud in circulation can be rapidly accomplished and the suction pit refilled with a different mud to suit the formation being penetrated, one contractor used several mud storage tanks and located a manifold at one end of the mud tank.

The manifold is made of six-inch pipe welded to the sides of the mud tank just below the top reinforcing angle iron rails. Pipe fittings are attached to the manifold for connecting discharge lines from the pumps to lead mud from the pit to storage. Storage tanks have hose lines instead of pipe so that accurate pipe fitting is unnecessary when setting the storage and mud tanks at the rig. The manifold and lines are so arranged that the drilling fluid in circulation can be dumped quickly into storage, and a new supply gravitated from another tank without appreciable loss of time.

How To—

Stabilize Engine Exhaust



Reaction from a sudden burst of steam issuing from the end of the drawworks engine exhaust pipe exerts a thrust against the line which can in time damage fittings or break connections. One contractor safeguards the exhaust line by means of an alteration in the usual exhaust pipe.

The final six feet of the line, extending

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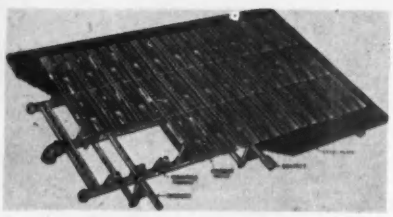

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through the dike of the waste mud pit, is of eight-inch pipe, the other being six-inch. Where the eight-inch is swaged down to fit the six-inch, a section some four inches across is left at full diameter, and is not welded to the six-inch pipe.

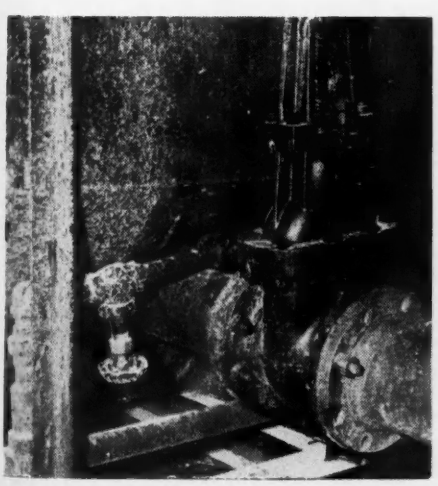
When steam first starts through the line, a portion exhausts through this vent, counteracting the push of the larger mass of steam at the open end of the line. This thrust from the vent holds the pipe against the dike, and prevents back-kick and pound. After the steam is coming steadily from the end of the exhaust, practically no steam emerges from the stabilizer vent.

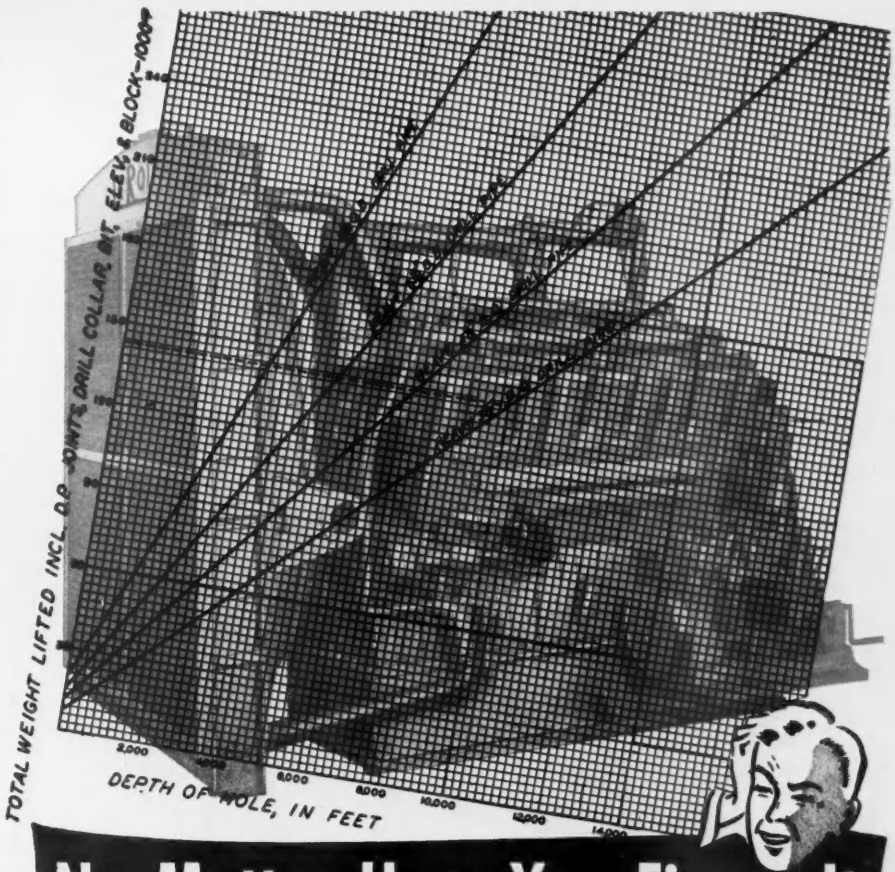
How To—

Empty Mud Tanks

Where steel tanks are used for mud storage, gradual hardening of the mud in the drain sometimes dams the outlet so tightly that no amount of gunning from the surface will clear the pipe. One company equips its pits with a pressure line, manifolded to the mud system as well as the fresh water main, with a valve adjacent to each drain line. If the tank fails to drain by gravity, the flushing line valve is opened, putting pump pressure through the small line just above the inner end of the drain nipple. The violent flow through the small line effectively loosens the material around the big fitting, and gravity flow results. Any material still sticking around the drain may be hosed or gunned down after the bulk of the material has flowed out.

The flushing line may also be used to stir up the bottom of the material in the tank, and thus to supplement the gun for more complete mixture of the tank's contents.





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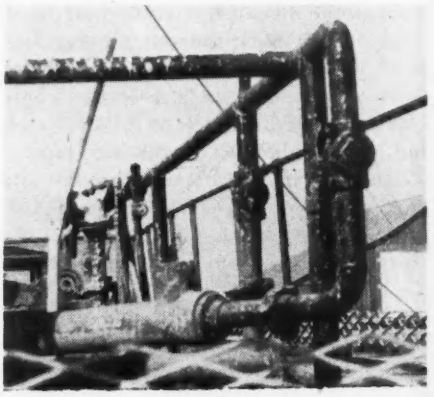
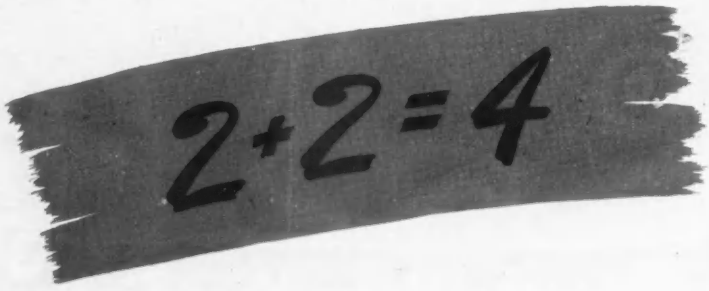
How To— Use Mud Lines for Walkway Guard Rail

Instead of building guard rails on the tank side of a steel mud tank, and subsequently laying lines from pumps to agitator and mixing nozzles, the guard rail can be a combination of a safety unit and utility lines. The line leads from the mud pump manifold in the usual manner and continues the full length of the tank to take-offs as required. Pipe standards as the mud line supports are set in ferrules welded to the tank so the unit can be removed easily if necessary.

In practice, the contractor who developed this particular setting made the line a permanent part of the mud tanks, which are moved intact without breaking down structures or breaking out tank fittings. Plug valves are set into the line for control, and lug type unions are installed for connecting or disconnecting any part easily and quickly without wrenches.





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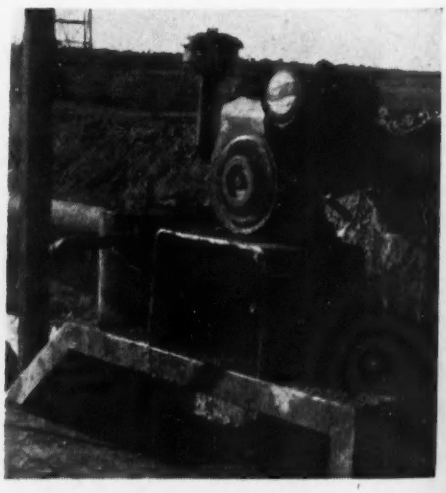

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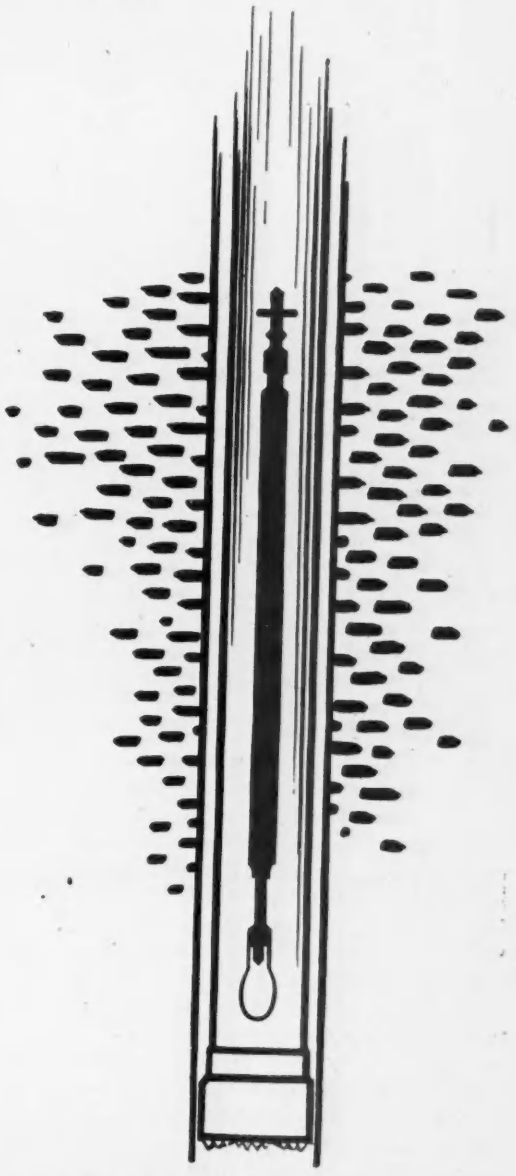

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ANADARKO BASIN . . .

Geology and Oil Possibilities

Part 4

Future of Basin Exploration

By ROBERT R. WHEELER
Consulting Geologist, Oklahoma City

THIS final section concerning Anadarko Basin oil possibilities will review briefly the distribution of favorable areas and some aspects of the economics and techniques of exploration. It is important to realize the relative progress of exploration in the more favorable provinces of the basin. For example, only one well has been drilled per 40 square miles in the northwestern Oklahoma counties and although most of these penetrated formidable thicknesses of hard Mississippian limestone and tested the Wilcox sands, few were drilled on detailed seismic mapping of the Ordovician rocks. Too often the reflections were from the Mississippian, whose structural relief does not duplicate earlier Paleozoic folding.

In the Anadarko Trough where the early Pennsylvanian sands are regarded as the most favorable objectives, we have to depend upon a few scattered deep tests for our evaluations of future possibilities. These are the Proctor 1 and the Reeder 1 tests in western and Southern Washita County; the Ada Noe 1 in northeastern Caddo County; and, to the south in the Cement fault block, the Culp 6; and the Chitwood production in central Grady County. Morrow sand production at shallow depths in the upfaulted Wichitas of northern Kiowa County indicates the favorability of these objectives where they are not completely truncated by early and late Pennsylvanian uplifts. On the other hand, the thin lenticular sands recently tested by Weller 51-11 in Caddo County suggest that the Morrow rocks grade to a less porous northern facies.

Only in the Southeastern Embayment where repeated discoveries have encouraged an extremely active wildcatting campaign from the apex of the basin in Murray County northwestward into Garvin, McClain and Grady counties, the many oil objectives and abundant traps are beginning to be appreciated. Certainly it is apparent that much of the Anadarko Basin has been inadequately explored.

The accompanying series of annotated sketch maps (Plate I) are designed to generalize the distribution and relative quality of the presently recognized oil objectives. These are briefly discussed especially as to drilling costs and expected recoveries.

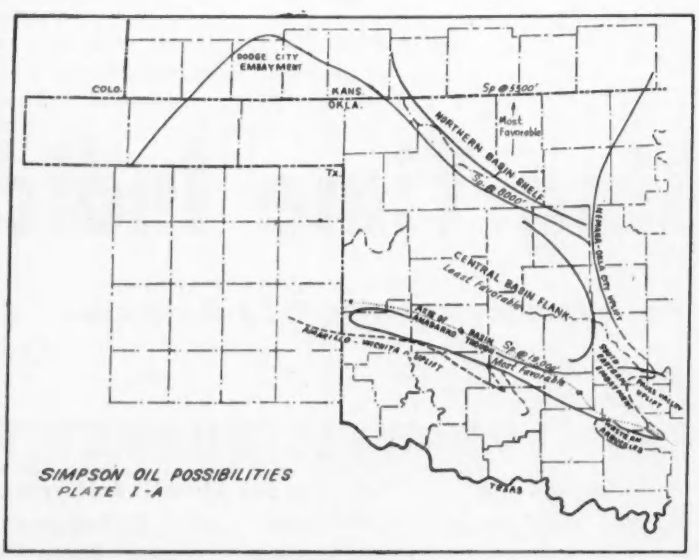
Ordovician Possibilities

As previously mentioned, the Arbuckle is not considered a favorable objective anywhere in the basin because of poor porosity and the improbability of finding duplicated in the basin the overlap type of Arbuckle reservoir producing in Kansas.

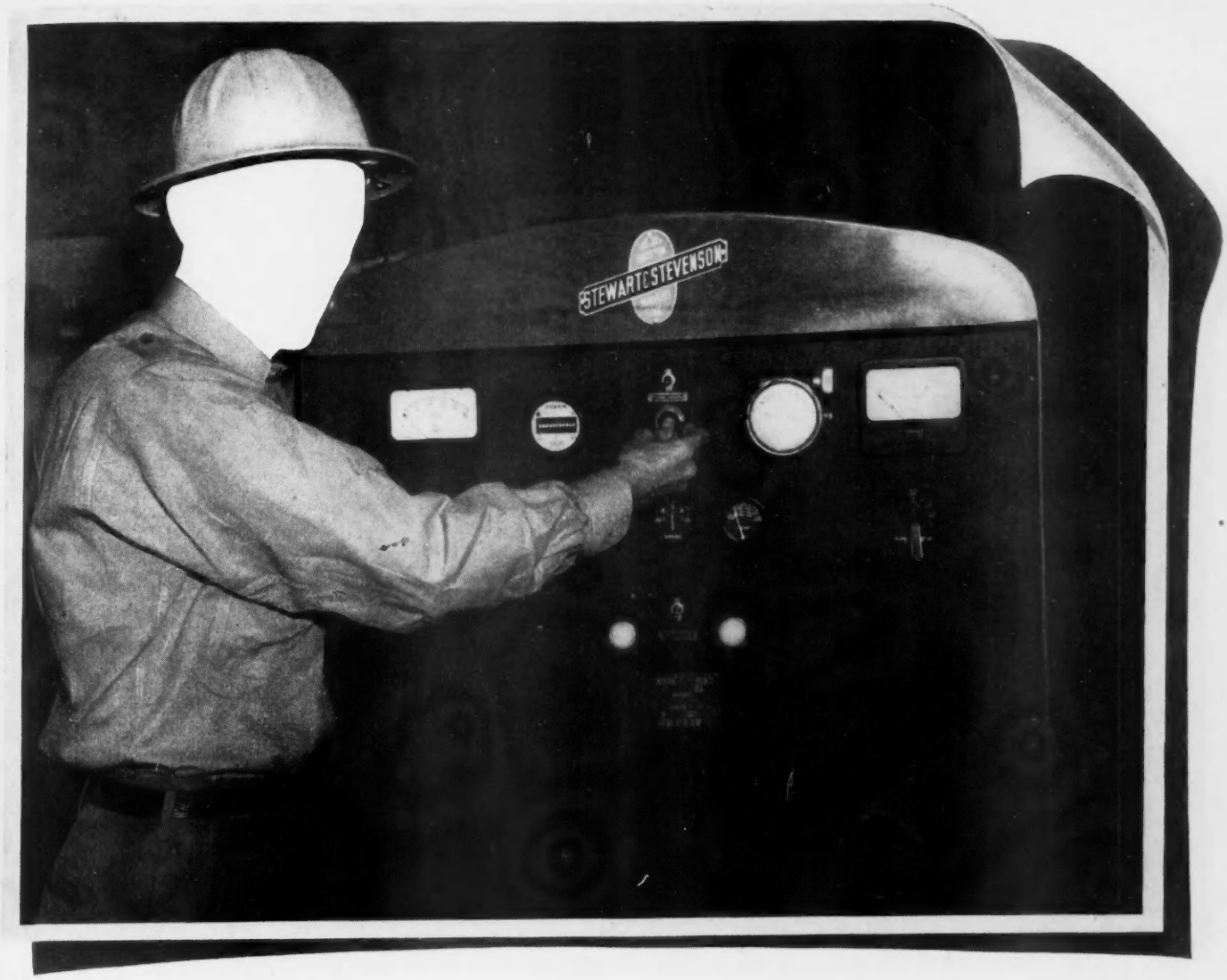
The overlying Simpson group doubtless will be the most prolific of basin reservoir rocks. Plate I-A shows a northern and a southern belt of favorable possibilities and a vast intermediate area, the Central Basin Flank of poor porosity, poor structural traps, no expectations of Ordovician unconformities or related traps, and improved porosity. Recovery estimates in the southern belt where the Simpson reaches maximum thickness and favorable sand development vary from a conservative 100 barrels per acre foot in the Lindsay area (SE 5N-4W) to several hundred in the Eola pool (1N-2W) and Apache (5N-10W). Lindsay is expected to produce 20,000 to 40,000 barrels per acre, whereas present estimates at Eola are in excess of 80,000 barrels per acre. North of Lindsay in McClain County the sands are much less porous and may never repay the costs of drilling and production. The 11,000+ foot wells in the Lindsay area cost about $10 per foot to drill and about $50,000 for pipe and other equipment. In the southern areas of steeper dips and a generally more cherty facies, drilling costs will be higher.

Simpson recoveries in the northern province are impossible to estimate upon performance of the high gas-ratio well (Olson Ott 1, Major County) and the fairly recent Hunter pool in Garfield County which is not considered a very prolific reservoir. Recent Simpson sand discoveries to the north in Barber County, Kansas, are very highly regarded. Depths to the Simpson sands increase from about 5500 feet at the Kansas boundary to about 8000 feet in central Major County, south of which the porosity is here regarded as very poor. Drilling costs increase also with the thickness of Boone limestone, which is an expensive factor due to chert content, from about $35,000 to $75,000 per well.

The Viola and Maquoketa (Plate I-B) where dolomitic in this northern province are possible objectives but no esti-



SIMPSON OIL POSSIBILITIES
PLATE I-A



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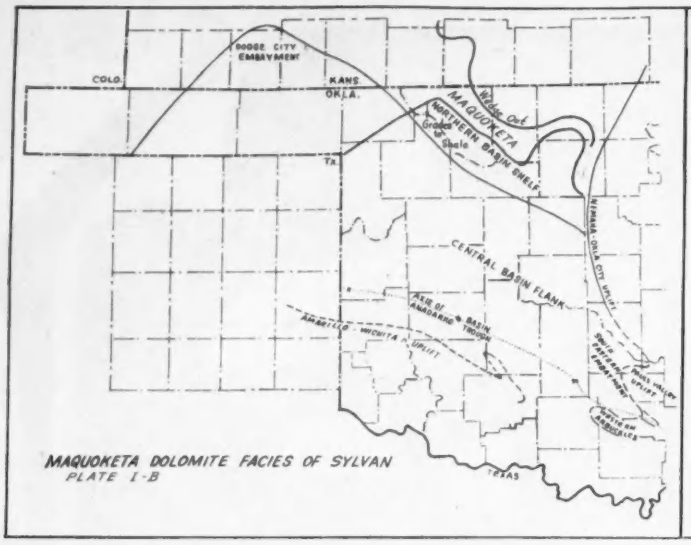
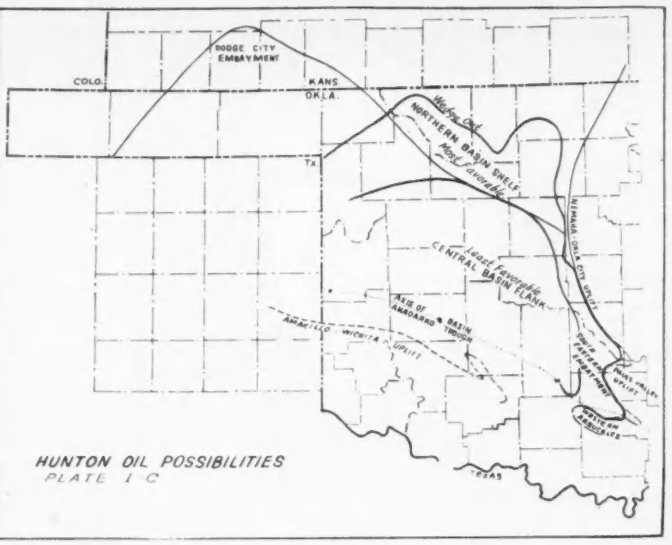


MAQUOKETA DOLOMITE FACIES OF SYLVAN
PLATE I-B



HUNTON OIL POSSIBILITIES
PLATE I C

mate of their productivity is yet possible except the estimates of 8 million cubic feet per acre from Viola producers in Barber County.

In the southern areas the Viola has tested oil and gas in several localities and is expected to be an important future producing zone; not so much as a primary drilling objective but as supplemental to Simpson recoveries.

Hunton Possibilities

Where the Hunton wedges out due to pre-Woodford tilting in the northern areas it tends to be dolomitized and commonly shows staining although there is as yet no Hunton production northwest of the West Edmond field. Porosity is exceptionally good in this latter area due, according to Swesnik,[3] to solution-enlarged factures, a process related to channeling and leaching of the exposed limestone. It is not expected that the estimated 8000 barrels per acre recoveries of West Edmond will be duplicated elsewhere in the basin. Certainly, Hunton performance (Bois d'Arc and Chimney Hill limestones) in the Southeastern Embayment has not been very encouraging. In the Lindsay and Southwest Wayne pools these limes are not expected to pay back in excess of costs. (Costs of Hunton producers to date include drilling and testing much deeper Simpson objectives. Bauman Ainsworth 1, 26-5N-4W, probably will pay out from Hunton. Nevertheless, the Hunton, just as the Viola limestone, may produce much future oil if only to salvage deeper failures (Plate I-C).

Mississippian and Morrow Possibilities

The Mississippian rocks appear favorable across the Northern Shelf and westward around the Dodge City Embayment where: (1) local concentrations of residual chert will be productive on structure; (2) sands, dolomitic zones and porous fossiliferous limestones of the Boone commonly show oil or gas, e.g., Beaver County, Oklahoma, and adjacent Meade County, Kansas; and (3) the sands and porous oolitic limestones of the Chester series wedge out by truncation beneath the Pennsylvanian (Plate I-D Figure 12).

The term Morrow is used here for the early Pennsylvanian sands to avoid discussion of its controversial subdivision, the Springer and Lower Dornick Hills. Since these two units are many times thicker in the Ardmore region, where each contains well developed sands, and thin northward into the Anadarko Basin by post-Lower Dornick Hills truncation, it seems likely that the transitional sand to shale sequence, e.g., in the Chitwood pool, is of Springer age. There is an observable thickness of at least 1000 feet of Morrow sands, possibly considerably more, in the Anadarko Trough. These wedge out north and east beneath the Deese and are faulted-up abruptly around the Arbuckle and Wichita Uplifts. (Plate I-E). Where these sands are structurally trapped as in Chitwood and in northern Kiowa County, they are very favorably regarded. The wedge out belt through Grady County is being actively mapped and leased. Its trend swings northwestward between the Binger well in 10N-10W, Caddo County, and the Oklahoma Natural Oakwood 1 to the north in Dewey County. Unfortunately facies changes from sand to shale are very likely to occur along the wedge-edge, because there is no genetic relationship between the original facies distribution and the direction of later tilting and truncation.

The Morrow sands will be one of the major drilling objectives of the Anadarko Trough where the Ordovician is at excessive depths. Recoveries at Chitwood are difficult to estimate because of the high gas-oil ratio and distillate production but are expected to be profitable. It is predicted that these sands will be thicker and more prolific in deeper parts of the Anadarko Trough.

Deese and Hoxbar Possibilities

Deese sand production where the producing zone averages 25 feet in thickness at Southwest Antioch is conservatively[4] estimated at 3000 to a more optimistic 4500 barrels per acre primary and possibly double this amount on secondary recovery methods. These sands vary considerably in permeability, especially basinward where they are finer grained, although commonly thicker. Deese sand wells, at an average depth of 6500 feet, cost approximately $60,000 to drill and equip. Basinward where porosity appears less favorable and depths are 1000 feet greater, recoveries will be marginal, but here Deese sands may be regarded as secondary objectives (Plate I-F).

Where the Deese laps-out on the Pauls Valley Uplift the succeeding sands of the Hoxbar may produce over-large areas as suggested by off-structure Hoxbar production in the East and West Pauls Valley Pools. These sands are locally more porous than those of the Deese but considerably more lenticular and unpredictable in distribution. Average recoveries in the Cement area from the remarkably well-developed Hoxbar sands are estimated in excess of 100,000 barrels per acre, but the equivalent sands are exceedingly thin, fine-grained and tightly cemented northward across the Anadarko Trough. Evidently coarser Hoxbar sands were derived from the bordering highlands during onlap, for porosity improves in this direction. Where these sands grade into the limestone facies typical of southern Kansas, stratigraphic traps are expected. Moreover, these porous oolitic limestones of the Kansas

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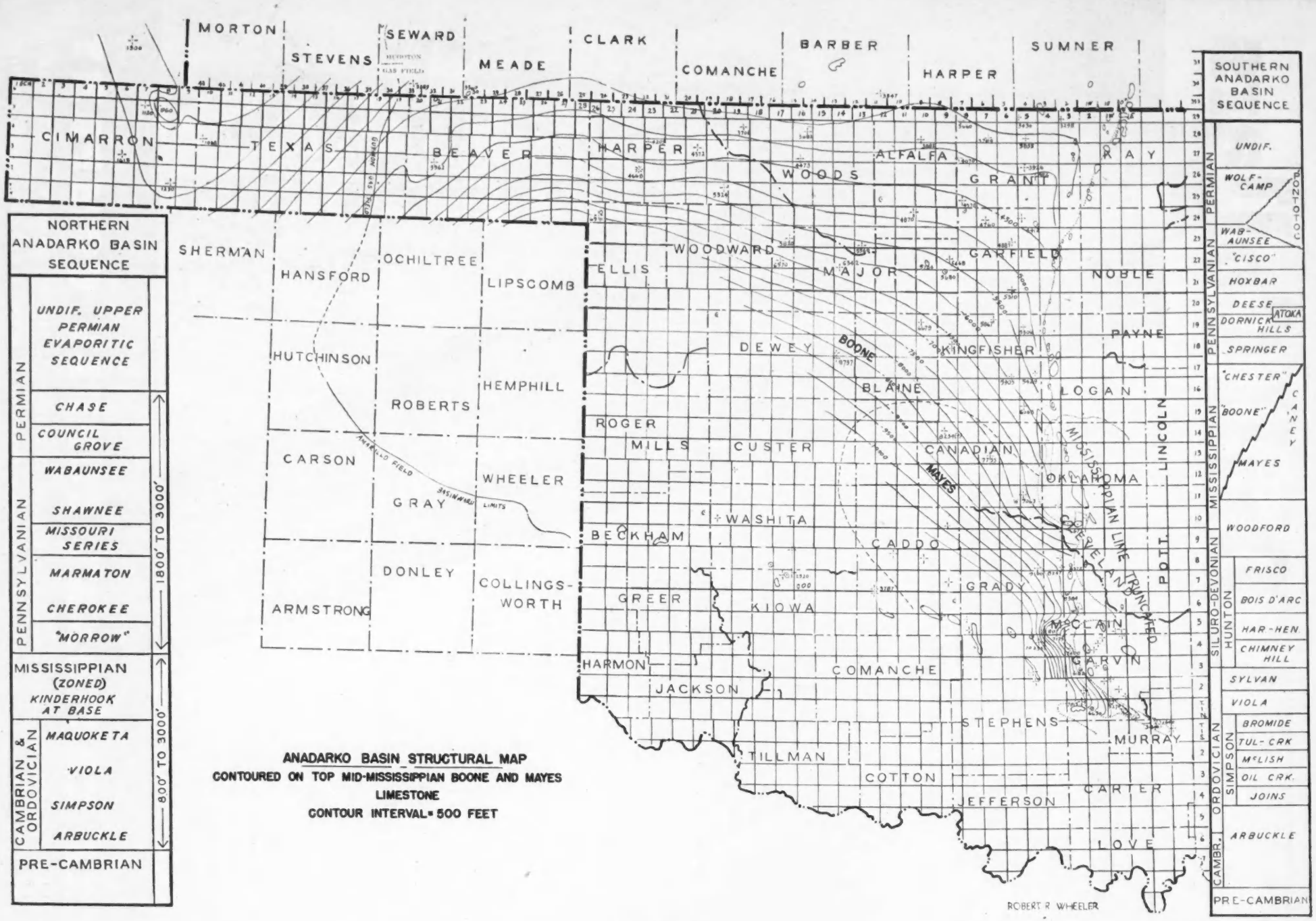
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SHAWNEE
MISSOURI SERIES
MARMATON
CHEROKEE
"MORROW"
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KINDERHOOK AT BASE
CAMBRIAN & ORDOVICIAN
MAQUOKETA
VIOLA
SIMPSON
ARBUCKLE
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SOUTHERN ANADARKO BASIN SEQUENCE
PERMIAN
UNDIF.
WOLFCAMP
WABAUNSEE
"CISCO"
HOXBAR
DEESE
DORNICK HILLS
SPRINGER
PENNSYLVANIAN
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BOWTOC
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"CHESTER"
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SYLVAN
VIOLA
ORDOVICIAN
SIMPSON
BROMIDE
TUL-CRK
McLISH
OIL CRK.
JOINS
CAMBR.
ARBUCKLE
PRE-CAMBRIAN
ANADARKO BASIN STRUCTURAL MAP
CONTOURED ON TOP MID-MISSISSIPPIAN BOONE AND MAYES LIMESTONE
CONTOUR INTERVAL = 500 FEET

FIGURE 12

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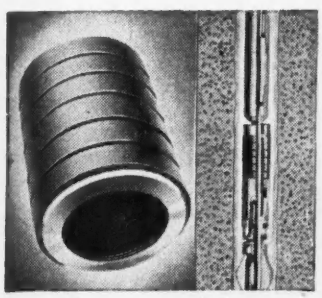

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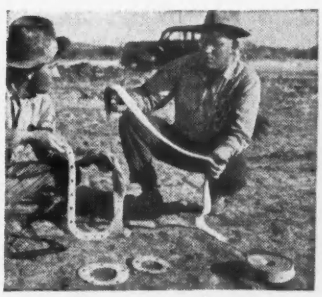

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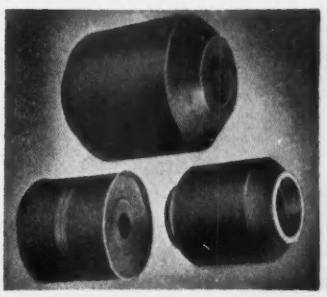

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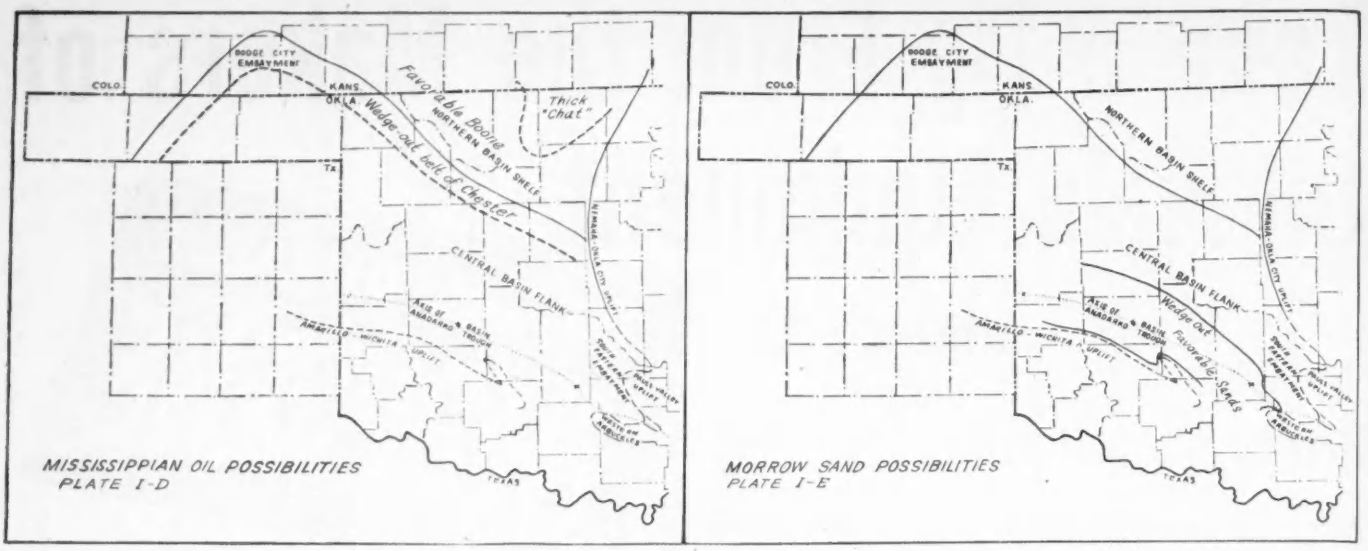

City and Lansing groups should be profitable objectives in northwestern Oklahoma as they are in Kansas (Plate I-G).

Permian Possibilities

Where Pontotoc detritus was adequately sorted and deposited in late Pennsylvanian structural depressions or on the flanks of uplifts, as for example at Carter-Knox, Chickasha and Cement these sands are fairly prolific, especially as gas reservoirs. Possibilities for production are favorable north of the Amarillo-Wichita Uplift where the late Pontotoc arkosic sands grade into Lower Permian porous dolomitic limestones. This dolomitic facies of the Wolfcamp swings northward across the Texas and Oklahoma Panhandles into western Kansas, localizing the extraordinarily prolific Guymon and Hugoton gas field with open flow potentials in the 20 and 30 millions of cubic feet per day.

Geophysical methods including gravimetric magnetometer, improved electrical-resistivity, and reflection seismograph techniques are all utilized in basin exploration, but of these by far the most successful is detailed seismic mapping in close coordination with subsurface geological interpretation. Reviews of exploratory drilling statistics indicate that most of the oil in this country is found by a combined geologic and seismic approach.

Neither magnetometer nor gravimetric mapping seems to enjoy much popularity in recent basin exploration, for a number of possible reasons. In the first place, the data acquired by each method are derived from an unascertainable depth and location and no matter how refined and mathematically fascinating are the various reductions of basic data to a contoured map, this map is not geological nor is it a direct measure of any geologic phenomenon. Therefore, there is commonly doubt as to the position and depth of the structural feature that is inferred to account for the geophysical anomaly. Although these are general criticisms, further difficulties arise in basin mapping. In the favorable northern basin areas, the structures are typically gently folded and of minor relief so that their recognition is difficult. On the other hand, the data are too crude to localize fault traps in the structurally complex southern basin areas. Finally, realizing that shifting of structural axes occurs with depth, the magnetometer and gravimetric methods could not be expected to map, for example, a truncated series of early Pennsylvanian sands at 13,000 feet beneath differently warped upper Pennsylvanian and Permian beds in the deeper basin areas.

Geochemical techniques, i.e., variations of soil analysis for hydrocarbon content, like the doodle-bug contraptions, can never be condemned (even after repeated failure) in the absence of a satisfactory geological explanation for their data.

Many of the criticisms regarding gravity and magnetic surveys apply also to surface geologic maps. The masking of minor folds by relatively unwarped later beds is further complicated in northern areas by the widespread effects of swelling and slumping due to hydration of gypsum and solution of Permian salts at shallow depths. Irregularities, particularly large-scale cross-bedding in the exposed Permian rocks of the basin, also make surface mapping uncertain.

In the deeper basin areas the obvious tendencies for shift in structural axes should discourage deep drilling located purely on surface mapping. For example, the Chitwood structure, with production at 11,000 feet, is located in the center of a surface structural basin! Across the North Lindsay structure, showing more than 500 feet of north dip in Ordovician rocks, the overlying Pennsylvanian beds at depths of 5000 feet show no north dip.

Faulting, which traps many of the deeper basin structures, rarely extends upward into the Permian rocks (exception: Carter-Knox field) and is not commonly mappable at the surface. Hence the use of aerial photographs, as a glorified form of "creekology" in an attempt to delineate faults by aligning "compatible" stretches of drainage pattern, seems fundamentally unsound. Several of the more obvious stretches of northwest trending drainage (Washita River near Davis, Oklahoma) are in complete contradiction to the subsurface control. Whether or not local concentrations of rectilinear gullying reflect jointing over structural highs remains to be seen. Certainly the interpretation of such superficial phenomena should be based upon a careful integration with, rather than as competition to, the available subsurface data before recommendations are made for leasing and drilling.

For some reason the more obscure methods of prospecting have a dreadful appeal to the non-scientific operator. Millions of dollars have been spent conducting and testing all sorts of non-technical surveys. This is the same operator who speaks of "being practical" in the distinct sense of "not being theoretical." While he would criticize as impractical the theoretical propositions that Deese sands should wedge-out and trap oil around the margins of the basin, he is the same operator who is impressed by the theory that soil analysis will show accumulations where the objectives lie at 10,000 feet, or the theory that somehow by rising 10,000 feet above the surface you no longer deal with superficials . . . that, in fact, you are seeing "deep-seated" effects.

Role of the Geologist

Geologists may distinguish themselves in the search for basin oil prospects not by merely describing the wealth of geological data made available by drilling

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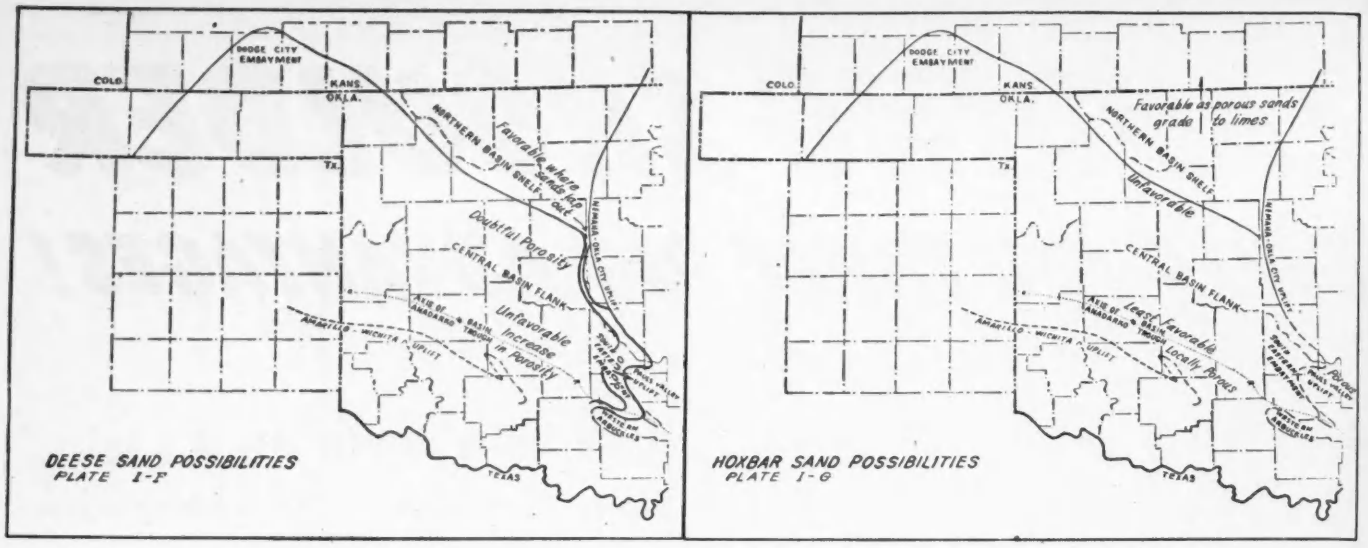

wells but by exercising their capacity for interpreting these data. The recognition of a Hunton wedge-out trap at West Edmond and Deese sand wedge-outs in an arc of producing pools around the Pauls Valley Uplift suggests that stratigraphic traps will be most abundant in the basin. These may be approached by studies of stratigraphic convergence[5] in which it is essential to distinguish the components of truncation and onlap. While the onlapping objectives wedge-out upon regional unconformities by the loss of beds from the base up, there need be no relation in strike between the onlap belts and the truncated objectives beneath the unconformity. Thus, during the structural movements and subsequent differential erosion of the older rocks, a plane of unconformity is established that predetermines the strike of onlapping younger rocks but does not necessarily reflect the trend of the truncated beds. Convergence studies permit the making of paleogeologic and iospach maps which eventually reveal the pattern of faults, folds and wedge-out belts, all of which contribute to a fuller understanding of the geologic history of the region.

When such studies are coordinated with seismic mapping, it is possible to delineate the wedge-edge of oil objectives with considerable accuracy. In such a program the geologist may supply the depth and stratigraphic position of reservoir rocks and the dip of the unconformity by which the convergence shown on seismic profiles can be divided into the components of onlap and truncation. The mapping of the Morrow sand wedge-out around the southeastern flank of the basin is being conducted as a combined geologic-seismic program.

Especially in the southern basin areas of complex faulting, geologists and seismologists must cooperate to work out the fault pattern, for in many cases the final picture has to be one of geologic interpretation. In such areas of steep dips and a grid-work of faults, seismic techniques are undergoing constant improvement, particularly in accurately computing the distant source of pulses from steep dipping beds by shooting cross-spreads as frequently as possible to determine strike and dip.

Yet, in spite of the unlimited possibilities for "discovery-thinking," one is impressed by the record of relatively ill-advised independent discoveries. By this term, coined by Levorsen, we think of controlled imagination and experience in evaluating geologic prospects in terms of the economics of acreage and drilling costs per expected recoveries—this at the expense of one's self-deluding enthusiasm for a novel viewpoint.

Occasionally it seems as though the geologist could scarcely keep up with the rapidity of discoveries and geologic data added by new wells, for as he industriously absorbs such evidence trying to fit it into the regional pattern of sediments and structures, another intrepid wildcatter is blithely drilling ahead on relatively inadequate information. The validity of this may range from the coaxings of a doodlebugger, or the beauties of a bootlegged seismic map, to merely the availability of a farmout lease and the dry hole contributions of his more wealthy brethren. But to these wildcatters, unenlightened as to the intricacies of the subsurface faults, folds, wedge-outs and facies changes and undaunted by the painful statistics of the probabilities of failure, goes credit for several of the basin oil fields: West Edmond, an unpredicted and enormous stratigraphic trap; Southwest Antioch, drilled as an Ordovician structure, found a Deese sand wedge-out; and similarly Southwest Wayne and Southwest Maysville were unexpected Hunton and Deese discoveries. One must conclude that so long as geologists can absorb and utilize new data and propose new ideas regarding favorable areas and so long as drilling operators remain unprejudiced, the rate of Anadarko Basin discoveries should be maintained because there is a wealth of oil still to be found.

Acknowledgements

To a great number of geologists in Oklahoma City who contributed with data and ideas the writer is very grateful. Especial thanks are due Robert M. Swesnik (Anderson & Prichard Oil Company) and Lynn B. Trombla and J. A. Mull (Central Exploration Company) for suggestions, criticism and long hours of analyzing controversial aspects of basin geology. Lewis Wallace of the Oklahoma City geological staff of The Superior Oil Company made available well data, cross-sections and drafting facilities which contributed immeasurably to preparation of this paper.

While these several sources of assistance are acknowledged with thanks, the writer must take responsibility for his presentation of viewpoints on many controversial problems, especially concerning the dating of orogenic movements and the prerequisites for local accumulations of oil. The irresistible temptation to illustrate in sketch-map form these conclusions as to favorable prospecting areas for each oil objective may be considered indiscreet, because future discoveries and evolving concepts will doubtless suggest many fallacies. However, if this presentation of contestable opinions will provoke additional research, all criticism will be gratefully received.

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ILLINOIS OIL DEVELOPMENT and Repressuring at Loudon

by
Carl G. Herrington and Max C. Sons
The Carter Oil Company

Automatic control of electrically-driven pumping wells in the Loudon pool permits intermittent pumping with minimum supervision on the part of pumpers.

OIL POOLS in the Illinois Basin have served as the proving ground for many advanced ideas in production technology and today pools such as Loudon and Mattoon are excellent examples of efficient production methods and techniques. This article describes the development of the Basin and the methods used to conserve oil in Loudon.

OIL field development as practiced in Illinois during the past ten years has seen the application of the most modern methods known to a typically aggressive industry. At the same time oil operations in this state have contributed a great deal to the technology and "know-how" of the entire industry.

Illinois drilling has made a sizeable contribution to modern trends toward streamlined and highly portable drilling equipment. An outstanding contribution in production engineering was the development of the multiple zone method of completion which was first tried in the Loudon pool of Fayette County and is now extensively employed throughout the country. A few wells at Loudon have as many as four pay zones open in a single well bore, with two sands producing through "windows" and the two lower pay zones producing from an interval of open hole below the bottom of the casing. The placing of "windows" opposite pay zones was effected in a number of ways during the evolution of developing a wholly satisfactory completion technique. In its present form, the most desirable method of exposing upper pay intervals to the well bore consists of including acid removable aluminum alloy lengths of casing in the casing string, spaced to appear opposite particular pay zones when the pipe is cemented in the hole. With removal of the alloy pipe intervals using acid, the pays then may be shot with nitroglycerin and the well cleaned out and placed on production, with shale and other formational materials separating the pay zones being prevented from caving or feeding water into the well by the casing left in the hole.

Aside from completion methods, Illinois oil operators have developed to a high degree of perfection electric well pumping and automatic time switch well control, wherein wells are operated almost automatically with only very limited attention by personnel. Loudon, Salem and Mattoon are typical pools where this technique has been operating successfully for some years.

In the forefront of modern thought on proper oil reservoir development is the return of gas to the formation dating from initial pool drilling, as practiced at Loudon, using an oil well placement program to take maximum advantage of gas injection and which will be described later in this paper.

The first known discovery of oil in the Eastern Interior Coal Basin which falls in Illinois, Indiana and Kentucky, dates 30 years before the drilling of the Drake well near Titusville, Penn. In 1829 a well drilled at Rennox Creek, Birkville, Ky., made 1000 barrels of oil per day, subsequently being abandoned because the drillers were looking for brine.

Oil was first discovered in Illinois in

About the Authors

MAX C. SONS joined The Carter Oil Company in 1936 as a laborer in the Seminole district and served as roustabout and student engineer until 1937, when he became a junior petroleum engineer. He became a junior research engineer in 1938 and senior petroleum engineer in 1939, serving in that capacity until his transfer to Billings, Mont., as division engineer. In 1946 he was made division engineer for Carter's Eastern Division.

CARL G. HERRINGTON began work for The Carter Oil Company in 1934 as roustabout. He spent a year in the tax department, Tulsa, then moved to Ponca City as engineer in 1936. Two years later he was transferred to Mattoon, Ill., as assistant division engineer and then was sent to Seminole, Okla., in 1941 as division engineer. In 1943 he was transferred to Tulsa, and in 1946 returned to Mattoon as superintendent.

1879 in the Litchfield pool, Montgomery County, at 670 feet. The next discovery was about nine years later when the Sparta pool of southwestern Illinois was drilled. The state's first major discovery was the Westfield pool of east central Illinois, opened in 1904. This was followed in 1906 by the discovery of a number of large oil reservoirs located in this same general area and all lying along the Wabash River. These discoveries ranged in depth to 1400 feet, the Consolidated Robinson pool, covering some 34,000 acres, being the largest.

Infrequent discoveries occurred between 1907 and 1928, with none establishing reserves comparable to those found in the 1904-06 period.

Peak production of the early development period for Illinois of almost 100,000 barrels per day was reached in 1908. Production gradually declined until in 1936 the state's average approximated but 12,000 barrels daily, produced from 13,500 wells. From the date of the first discovery to the end of 1936, approximately 420 million barrels of oil had been produced from 92,000 proven acres in the state.

Typical of the history of development in oil-producing areas throughout the world, more advanced geological and geophysical techniques and greatly improved drilling methods were responsible for a revival in the oil finding effort in Illinois dating from 1937 and continuing to the present. Largely centered in the Illinois Basin, which constitutes the south one-third of the state, spectacular discoveries were made at Patoka, Clay City, Noble, Centralia and Loudon in 1937 and Salem in 1938. In 1937 about 450 wells were drilled, of which almost 300 were completed as oil producers. Wildcatting and pool development were greatly accelerated thereafter, and in 1940 alone more than 3000 producers were completed. Development during the war years declined sharply, the low of about 1100 oil well completions in 1945 being followed by some 1350 completions in 1946. By the end of 1946 the state's total number of producing wells totaled almost 29,000, more than double the number of producers in 1936.

Among the first large pools discovered with the revival of Illinois wildcatting about ten years ago was the Loudon pool of Fayette and Effingham counties. Approximately 15 miles in length and three miles in width at the widest point, the productive limits of the pool encompass 22,300 acres, production being obtained from four sandstone zones and one limestone formation. The discovery well, The Carter Oil Company's Miller 1, was drilled to 3170 feet in the Devonian limestone and was plugged back and completed in the Weiler sand at approximately 1500 feet for an initial potential of 75 barrels of oil and no water per day. During the drilling of the well the Paint Creek and Bethel sands also were located.

During the summer of 1938, while development was proceeding in the vicinity of the discovery well, extensive wildcatting proved several nearly simultaneous extensions to the Loudon pool. Highly competitive drilling began immediately and by the end of 1938 more than 400 wells were producing in the pool. Subsequent development was rapid, almost 1000 producing wells having been drilled in 1939 and more than 400 in 1940. Until 1941, development at Loudon was confined to the Chester series Weiler, Paint Creek and Bethel sands encountered at an average depth of approximately 1550 feet. Exploitation of the 3100-foot Devonian limestone reservoir took place in 1941-43. This reservoir extends over 3000 acres, and 83 producers were drilled. Development of the Aux Vases reservoir, deepest of the Chester sands, was commenced in the summer of 1944 by deepening existing wells, and by the end of 1945 a total of 47 wells had been opened to this horizon. Almost 2000 producing wells were completed at Loudon. Excluding 37 wells converted to gas injection service in the Chester sands, there are approximately 1850 wells at present. There are seven major and 43 independent operators in this pool.

Peak production from the Loudon pool . . . Illinois' largest single oil-producing area . . . occurred during July, 1940, when 74,500 barrels per day were produced. Current daily average production amounts to 20,500 barrels. The accumulated production to July 1, 1947, was about 134 million barrels.

With localized exceptions, spacing in the Chester sand development at Loudon is either ten or 20 acres per well, with the 20-acre pattern confined to the gas injection area in the north part of the pool where the producing wells are arranged in an octagonal design with eight producing wells around a central gas injection well, these arrangements resulting in each oil well being directly affected by two gas input wells in most instances.

The Devonian reservoir was developed principally with a spacing density of 40 acres per well, with a 20-acre spacing pattern used to a minor extent.

Gas Repressuring at Loudon

With the revival of oil development in the Illinois Basin during the late 1930's, gas repressuring and pressure maintenance were a planned part of ultimate depletion of many of the reservoirs. Today large and expensive gas injection installations are in operation in a number of Illinois pools discovered within the past ten years. Typical of modern trends in gas injection, a large fraction of the Loudon pool has been repressured almost from the initial well-drilling campaign. Thus, unlike most gas return projects where the reservoir's natural energy is fully exploited before gas is injected, a substantial fraction of all the produced gas has been, and is being, put back into the reservoir.

There are two general methods of augmenting natural reservoir energy in use in the Loudon pool. The most extensive is gas repressuring and gas pressure maintenance which is used in the Chester sands, and the other is pressure maintenance by the injection of water which is being applied to the Devonian lime. The gas repressuring program affects 775 producing wells in 11,780 of the pool's 22,300 productive acres. Gas is injected into the producing sands at 135 input wells of nine participating operators. The Devonian water injection project affects the 3000 productive acres of this formation with water being injected at five wells around the oil-producing area.

Gas injection was begun on an experimental basis November 29, 1938, in the north end of the pool at five input wells with gas being compressed at what is now The Carter Oil Company's Dove plant. Producing wells, which are approximately 1550 feet deep, were spaced according to what is known as the sunflower pattern in which two producing wells are located diagonally on every square 40-acre tract to form an octagonal pattern around each input well. Injection in the sunflower pattern was found to be successful and the area was expanded as development continued by drilling input wells along with producing wells. This area now covers approximately the north half of the pool and contains 98 gas input wells and 477 producing wells located on 9120 acres. A total gas volume of about 3.4 million cubic feet is being injected in the area daily, and thus far a total accumulated volume of more than 7 billion cubic feet has been returned to four producing sands. This gas is compressed at both the Dove and Taylor plants to 600 pounds per square inch and is injected at pressures ranging from this value down to 70 pounds per square inch. A system containing 30 miles of 2, 3 and 4-inch pipe carries gas from the plants to the input wells.

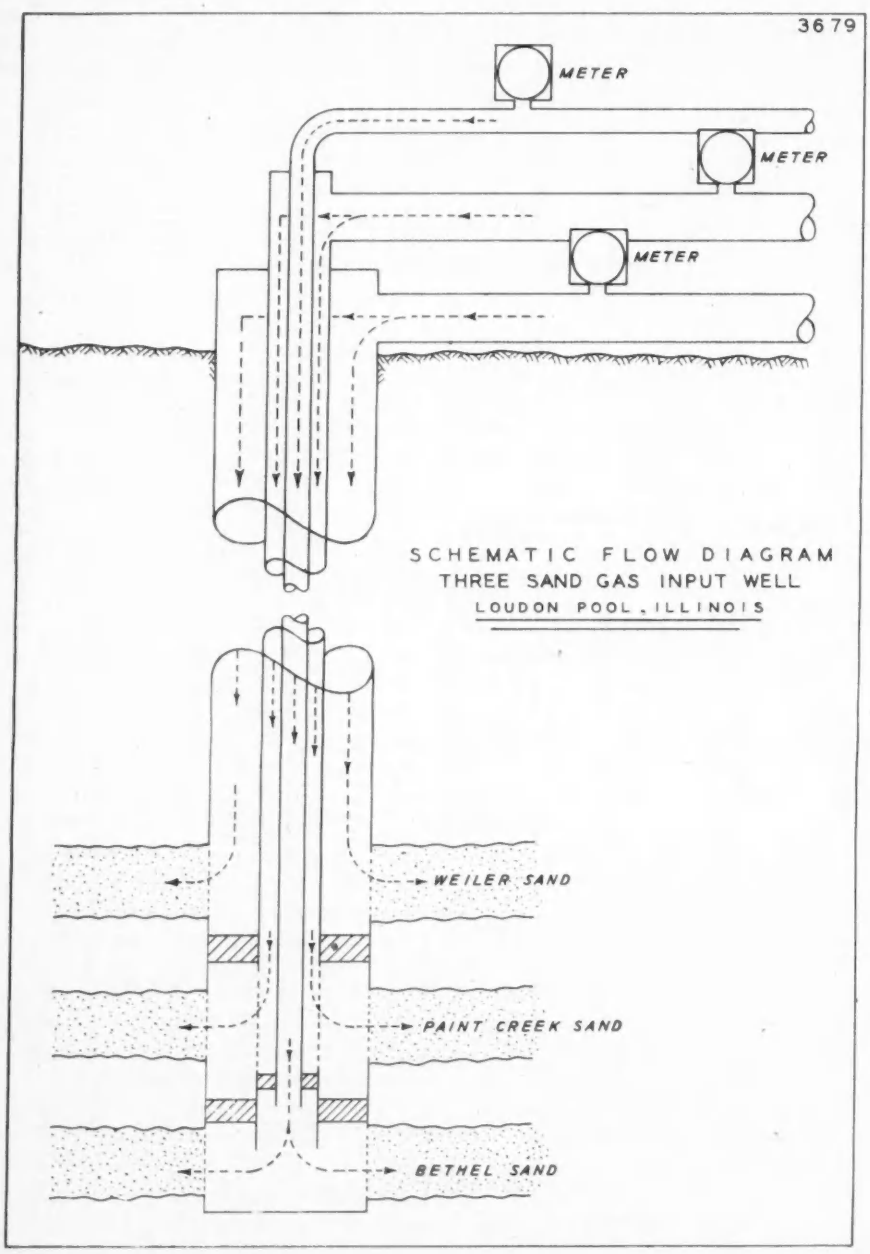
Numerous benefits have been realized from injection of gas in the sunflower pattern area and a favorable increase in ultimate recovery is anticipated. Among the first effects recognized was that of many wells beginning to flow which pumped initially. Eighty-six wells in the injection area have been converted from pumping to flowing as a result of gas injection. Another effect is the retarded decline of bottom-hole pressure in the

MAGNOLIA-CLOW REPRESSURING OPERATION, LOUDON POOL, ILLINOIS

producing sands. The current average pressure in the injection area is 170 pounds per square inch compared with 20 pounds per square inch in the south half of the pool. In addition, the oil potential decline has been much less than in the unrepressured areas. The injection program in the sunflower pattern area is expected to increase the ultimate oil recovery from this area; however, it is too early in the life of the operation to foretell accurately the recoverable increase.

As oil production declined in parts of the pool outside the sunflower pattern injection area where a denser well spacing pattern was employed and the wells operated at capacity production rates, interest grew in the use of gas repressuring to sustain producing rates. The first injection of gas outside the sunflower area was begun in June, 1942, when one operator converted two producing wells to gas input wells, drew the gas produced by surrounding wells through a compressor, and injected it into the producing formation. During the following years other operators converted producing wells for input purposes and repressuring operations expanded into the south end of the pool. Thirty-seven gas input wells now return gas to three producing sands in these low-pressure repressuring projects, 298 producing wells having been affected over 2660 acres. A total volume of 950,000 cubic feet per day is being injected currently and the accumulated injected volume now exceeds 600 million cubic feet. Gas repressuring in these projects has thus far resulted in an oil production increase of 270,000 barrels for all participating operators and corresponding benefits to royalty holders and owners of mineral rights.

Control of producing schedules, time switch pumping periods, and gas input rates, necessary in the proper operation of all repressuring, have been carried out through a program of continuous well testing. These well tests in which the oil, gas and water production of individual wells are measured, along with other factors, are used to maintain as nearly as possible the most efficient produced ratio of gas to oil and to keep a proper balance of the gas and electric pumping loads on the plants. The gas-oil ratios measured are used in following the reactions to repressuring, regulating the injection rates at the input wells, and controlling in general the operation of the project.

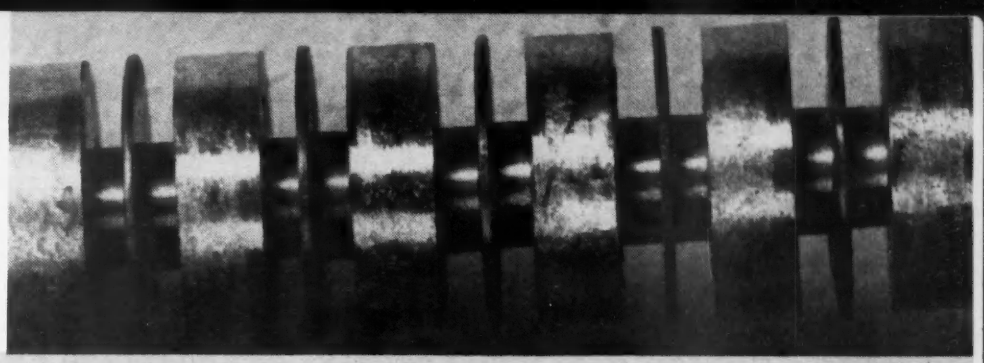


SCHEMATIC FLOW DIAGRAM
THREE SAND GAS INPUT WELL
LOUDON POOL, ILLINOIS

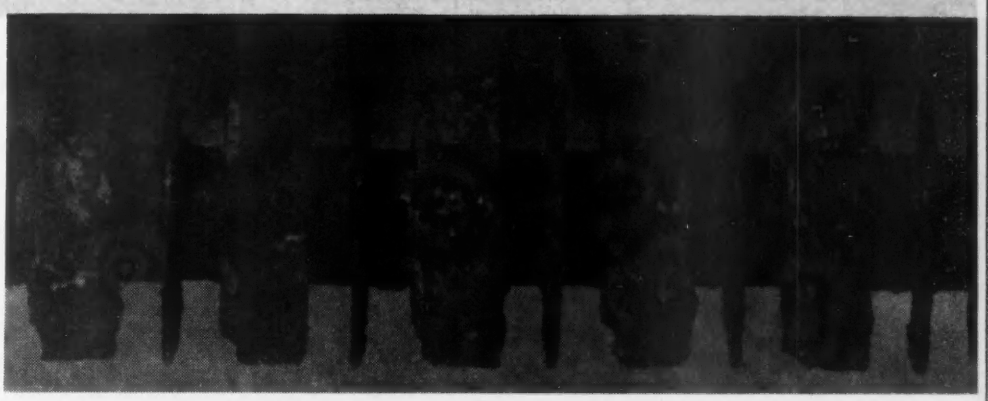
The Devonian lime into which water is being injected to maintain pressure lies at a depth of about 3000 feet, is productive over 3000 acres, and at the present time produces 2900 barrels of oil and 18,000 barrels of salt water daily from 75 wells. Five input wells around the edge of the oil productive area are used to return water to the Devonian. The return of water to the Devonian has maintained the pressure in this formation very close to its original value. This pressure is now 1294 pounds per square inch, only 56 pounds per square inch below the original pressure in 1941 when development began.

It is estimated that production of oil in the ten-year-old Loudon pool will continue for approximately 50 years in the north end of the pool where pressure maintenance and modern recovery methods have been applied almost from the inception of the pool. An estimated ultimate increase in production of more than 12 million barrels of crude and lengthening of the productive life of the area by approximately 30 years is forecast as a result of gas injection although, as has been indicated above, it is too early in the life of the operation to make an accurate forecast. In the south end where highly competitive conditions led to ten-acre well spacing instead of the 20-acre pattern to the north and prevented early utilization of pressure maintenance and other steps to increase ultimate recovery from the reservoir, the anticipated life of the pool is estimated at approximately 25 years.

An average Illinois Basin reservoir will yield ultimately about 25 percent of the original oil in place by primary operations, leaving three times as much oil in the reservoir pores as the amount actually produced. High producing rates give way to rapidly declining volumes producible, the day finally arriving when an operator is producing so little oil he can no longer afford to continue operation. Oil operators have increasingly recognized that gas artificially injected into the reservoir succeeds in reducing oil saturation. Today with new oil reservoirs becoming increasingly difficult and expensive to find, even greater emphasis is, and must continue to be placed on secondary recovery operations, of which gas injection is the most common.



COMBATING SCALE FORMATION



Zinc treater unit used to combat scale showing comparison between new unit (top) and one that had been in use for eight months in a well in Southwest Texas. Corroded zinc plates are shown in bottom section.

A METALLIC treater consisting of an iron rod on which are strung alternate copper and zinc plates has found application in reducing scale or "gyp" formation in oil field emulsion treaters and boilers. The rod is immersed in the fluid and the scale-forming elements attack the zinc, setting up an electromotive action which results in precipitating the corroding scale and prevents its encrustation within the pressure vessels. It also has been found applicable in reducing scale on pumps, rods and tubing.

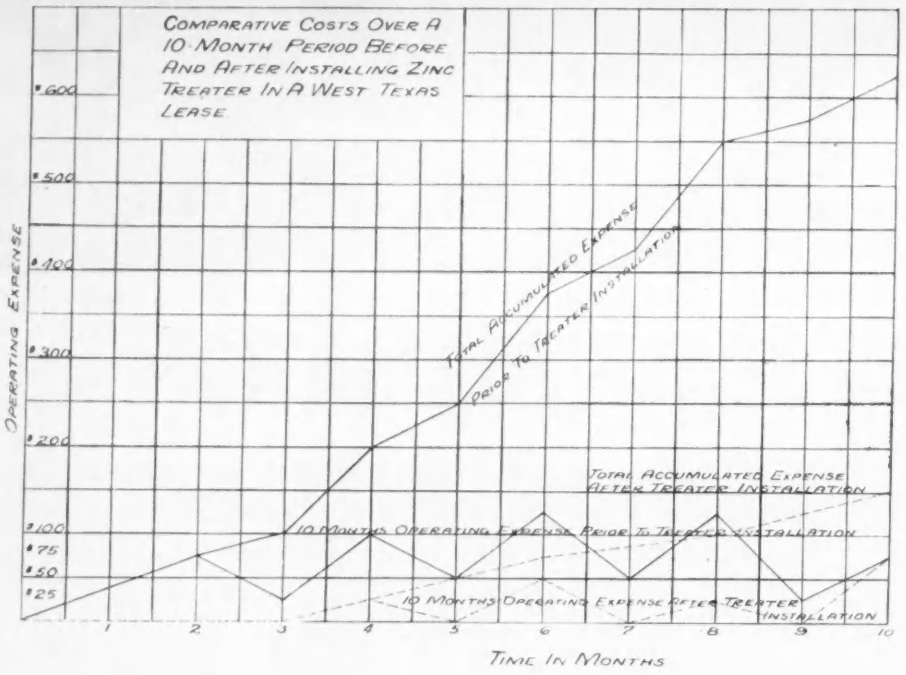
By R. B. WALTER

A MAJOR problem faced by oil producers is presented by the formation of scale or "gyp" in surface and subsurface equipment. This problem, perhaps, is most acute in the Southwest Texas and New Mexico areas where produced waters are high in calcium and magnesium and where scale deposits plug flow lines, salt water lines and tubing perforations, adhere to pumps, rods and tubing, form in emulsion heaters and treaters, and cause trouble in various other ways. Scale or gyp may be present wherever water is treated under temperature and pressure such as in boilers, in the water jackets of water cooled engines, in radiators, and in hot water tanks.

Some chemicals and chemical compounds have been used for years to combat scale formation with more or less effectiveness. About a year ago an electrolytic method was found whereby a sufficient amount of zinc could be dissolved or ionized in scale-forming fluids and in many instances has produced effective results.

The new technique, employing a mechanical or metallic treater, was introduced not only to remove old scale deposits but also to prevent redeposition. The device was first tried out in an ordinary home water tank. It consisted of a 16-inch iron rod threaded at each end on which were strung copper and zinc plates ⅝ inch in diameter, separated by a brass spacer ring. The plates and spacer rings were drawn together and held by nuts screwed onto each end of the rod. Before installation, the tank was drained and inspected. The drain cock was so badly scaled up or corroded that it could not be opened and had to be removed. Inspection revealed that the opening in the tank had become completely scaled over. A hole was drilled through the scale, which was found to be between ⅜- and ½-inch thick, and the water drained out. The device then was lowered into the tank through the hot water connection and suspended in the water by a wire so that it hung in the upper third of the tank where the water remained warm. After four weeks the treater was removed and the water drained out into a pail where about an inch of scale col-

About the Author: R. B. Walter was born in Delano, Minn., and received a degree in mining engineering from the University of Minnesota, shortly thereafter moving to Butte, Mont., where he was chief chemist for East Butte Mining Company. He spent two years in South America as a mining engineer. Returning to the U. S, he entered the oil business in Wyoming as petroleum engineer for Midwest Refining Company. After two years in Florida heading a survey party, Walter went to Oklahoma for the Indian Territory Illuminating Oil Company and was assigned to the Greater Seminole District. He later joined Kobe, Inc., where he specialized in pumping and corrosion problems. During the past eight years he has been a technical advisor and consulting engineer with headquarters in Oklahoma City.



lected at the bottom. The zinc plates on the treater were slightly scratched across the sides where they had been attacked by the water (electrolyte). The treater has been in continuous use in this water tank for experimental purposes and scale deposition has become progressively less until only very small amounts are observed. Apparently the zinc plates have succeeded in not only removing but in inhibiting the formation of scale.

Scale Formation

The formation of scale deposits is an electro-chemical process. It is chemical in that the scale-forming material is dissolved or ionized by the water, and electrical in that this material is attracted to the metal of the equipment used in producing and treating the water and/or mixture of oil and water under temperature and pressure, and forming a crust thereon. Calcium and magnesium compounds being easily ionized by underground waters furnish a large percentage of the scale-forming material in the water as they are broken up into positively charged calcium and magnesium ions and negatively charged radicals. These ions and negatively-charged radicals, as well as those of any other scale-forming elements that may be present, are attacked by the iron, an amphoteric element, that comprises the body of the metal, adhering to it and forming scale. This forming of scale deposits on the iron, the most powerful magnetic substance known, follows out the molecular theory of magnetism "that every molecule of a bar of iron is regarded as being itself a permanent magnet, and under ordinary conditions, these molecular magnets are scattered haphazard throughout the bar so that no noticeable fields of force are produced in the space surrounding the bar."

Water flowing through its surface and underground courses comes in contact with and dissolves in varying amounts numerous soluble mineral salts, the most common and widely distributed being the carbonates, chlorides, sulfides, sulfates, nitrates and silicates of calcium, aluminum, sodium and magnesium, as well as the oxides of iron and aluminum. Going into solution with water, some of the alkaline salt compounds, such as the sulfates, are broken down or ionized so that the primary elements, sodium and calcium, both positively charged, are separated respectively from the negatively charged SO or sulfate radical in which the sulfur and oxygen are bonded because of the greater affinity of the former for the latter than for the elements sodium and calcium. These two elements are present in the fluid as positive ions, or are electrically charged due to the loss of one or more of the electrons of their atomic structure which in turn were absorbed by the SO or sulfate radicals.

These sulfate radicals, having absorbed a given number of electrons, greatly intensify the fluid or electrolyte. Because of the difference in potential between the ions and sodium, calcium or any other alkaline salt compound that may be present, and the electrically-charged or ionized radicals, an electromotive force is created which has a definite voltage and current density. These forces increase in density where fluids (electrolytes) are treated under pressure and increased temperatures. This electromotive force constitutes the principal electrical system that exists under these conditions, with the possibility of other electrical systems being present, each of which emits electrons of certain density, velocity and reaction.

Treater Effects

Successful results observed in the preliminary tests of the copper-zinc treater resulted in the treater being introduced into oil-field operations where it appears to have successfully removed old scale or "gyp" deposits and to have prevented its redeposition in a number of installations. Copper and zinc, two of the most common and powerful electromotive force elements known, when immersed in fluid form a series of galvanic cell couples capable of generating a current having a density several times greater than that of the electrical systems existing in the fluid. This electromotive force is created at the expense of the zinc plates which are attacked and dissolved by the fluid being treated. As they dissolve, the zinc plates perform a two-fold function, one in emitting electrons to extend ionization, and the other to induce more of the metal to go into the fluid.

Zinc, while one of the strongest and most active negative metals, is covered with positive ions or protons that are dissolved and/or released when the treater is immersed in the electrolyte. This process creates an electromotive force capable of emitting electrons of the same density, velocity and reaction, as those sent out by the electrical systems existing in the fluid, which are able to extend ionization to a more advanced degree. This latter process causes a more rapid and complete decomposition of the incomplete compounds or products originally formed, followed by a rapid and complete rearrangement of the atoms and/or molecules, thereby forming stable compounds, which are chemically inactive, as well as neutral electrically, therefore harmless. The positively-charged zinc ions released in the fluid tend to form a jelly-like mineral salt compound which has a great affinity for the scale-forming precipitates to which it is attracted in the fluid. A colloidal film is then formed around the molecules and/or particles of the scale precipitate by this mineral salt compound, which having an amphoteric reaction is neutral electrically, so that the precipitated material is not only inactive chemically, but neutral electrically. In this process of decomposition in the electrolyte (fluid), some of the positively charged zinc ions unite with the free hydrogen and oxygen ions present, forming zinc hydroxide, which, being also amphoteric, will in turn unite with any

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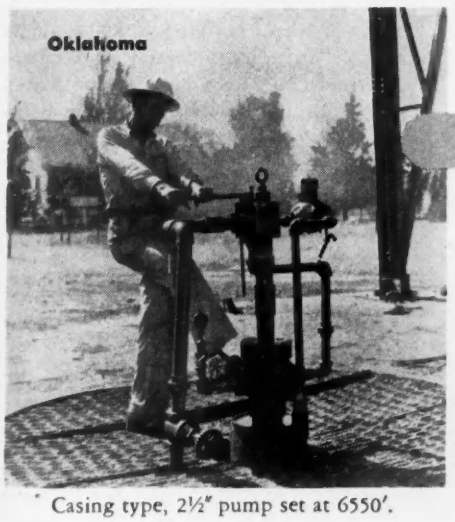

Casing type, 2½" pump set at 6550'.

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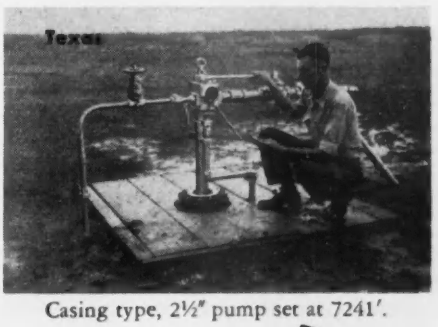

Casing type, 2½" pump set at 7241'.

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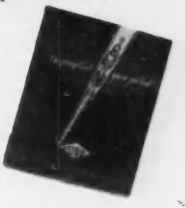

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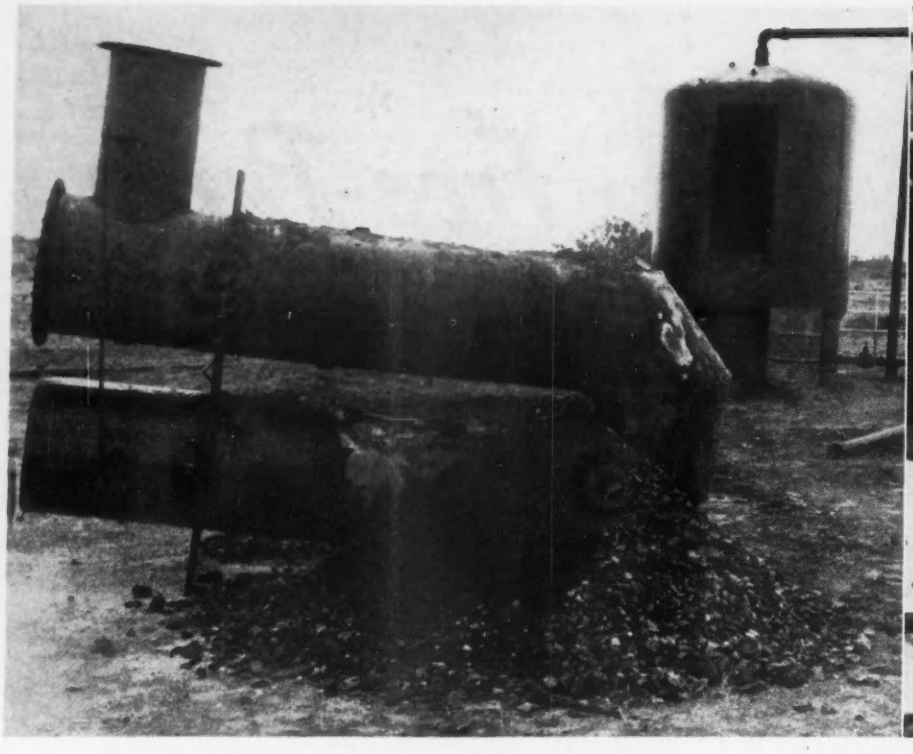
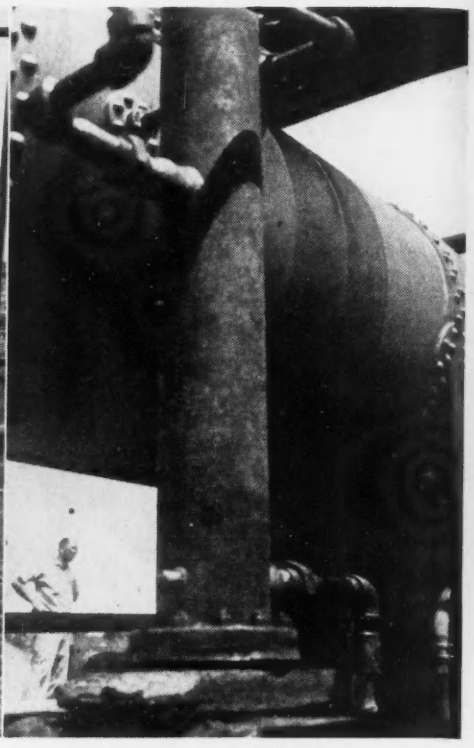


Heating unit (foreground) of an emulsion heater showing scale accumulation and its effect on the fire tube. (Hobbs, N. M.)



Boiler unit with vertical treater shell. Water passes through shell before entering boiler tubes.

metal ion present, with the latter replacing the hydrogen ion. The scale-forming material, precipitated out of the fluid by these chemical and electrical actions and reactions, is a soft, flaky sludge, easily drawn off.

One of the first emulsion heater installations for scale removal and prevention was made in New Mexico. The heater selected for the test was of standard size with a settling tank connected by a four-inch line. A salt water disposal line extending about 300 yards carried the salt water from the tank to the pit. The system was inspected and cleaned 30 days before the installation was made. At the end of 30 days it was found that a scale deposit approximately ⅛-inch thick had accumulated on the fire tube with a like amount in the four-inch pipe line as well as in the salt water disposal line. After the installation had operated for about 60 days it was found that the salt-water disposal line was free of scale. Final inspection revealed that the fire tube, connecting pipe line and salt water disposal line were free of scale deposit. During the 60-day run it was found that between 15 and 20 percent of the zinc had been dissipated.

Another installation was made in an emulsion treater in West Texas where the rapid formation of scale on fire tube and shell made cleaning necessary every few weeks. Since the system had not been cleaned for a considerable time prior to installation of the treater, a large deposit of scale was found on both the fire tube and shell. Units were placed in the lower section of the treater and directly on bottom. After four months an inspection was made to ascertain the extent to which the zinc plates had been attacked and dissolved by the water. Between four and six inches of decomposed scale mixed with a fine flaky precipitate were found at the bottom of the treater, indicating that the units not only had loosened and removed the scale deposit from the fire tube and shell, but apparently also had prevented deposition of scale-forming material. Units were found in good condition with only a small amount of zinc having been dissipated.

Another installation was tried in southern Oklahoma where scale accumulated so fast that it was necessary to shut down and clean out every 30 days. Prior to installation of treater units the scale deposit was so firmly encrusted on both the fire tube and walls of the emulsion treater that it was necessary to cut it away with chisels. After a 30-day run the scale deposit on the fire tube and walls was found to be soft and easily removed. An additional copper-zinc unit was installed and after the second 30-day run it was found that the scale-forming material had been precipitated out of the water and accumulated in the bottom section of the emulsion treater with pieces of old scale which had been loosened. After four months, about six inches of slime mixed with pieces of old scale were found when the fluid was drained off. This precipitate was easily washed out through the drain with a small amount of water.

Installations have been made in other sections of the Southwest which have not given results as good as those described. In most instances, however, the cause of failure was found to have resulted from an insufficient number of copper-zinc units used in the installation. Field tests prove that unless sufficient treater strength is available to treat the volume of water handled so as to render the scale forming material in it inert, the latter will collect on the zinc plates. This action is due to the zinc being stronger electrically, therefore more active than the metal of which the vessel or container is made. If this occurs the fluid cannot reach the zinc and the treater becomes inactive.

To achieve effective results the operator should study the problem carefully and determine the temperature and volume of water to be treated and the amount of scale-forming material present in the fluid, as evidenced by the rate of deposition. It is essential that the temperature of the fluid be approximately 100° F. as zinc dissolves in warmer fluids with its rate of dissipation increasing with higher temperatures. Field tests on a number of installations indicate that if sufficient copper-zinc units are installed to insure adequate dissolution of the zinc by the fluid under treatment, practically any type of scale can be removed while preventing further deposition by precipitating the scale-forming material out of the fluid.

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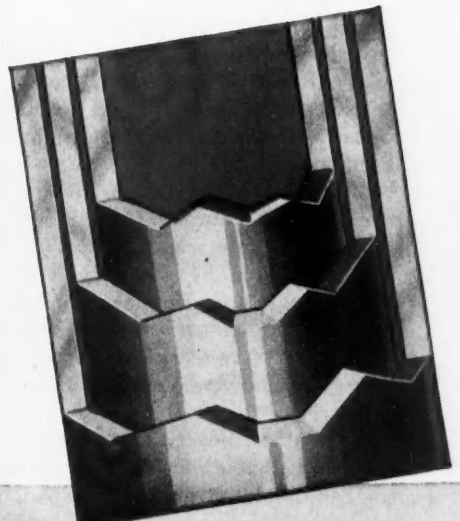

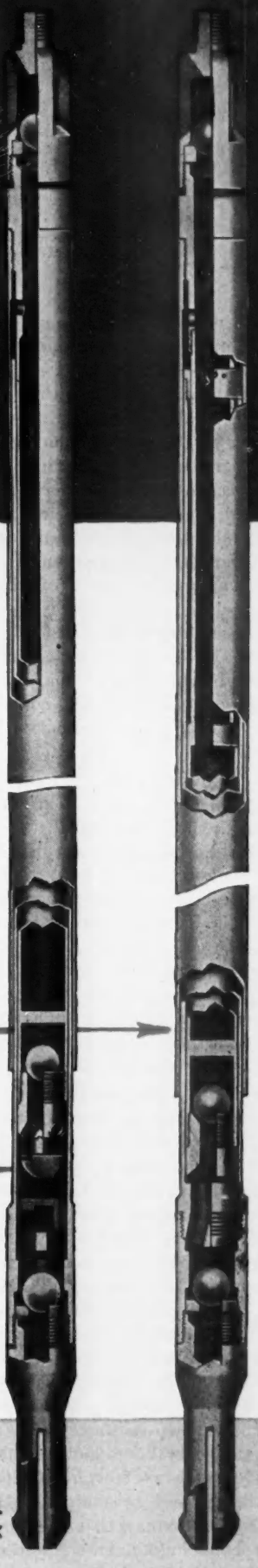

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Illustration at left shows fluid packing in color. It is actually the fluid being pumped.

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Water-flood Spacing

By S. T. YUSTER
Division of Petroleum and Natural Gas Engineering,
The Pennsylvania State College

A MATHEMATICAL approach to the determination of optimum well spacing for flooding operations, whether flowing or pumping, is outlined and basic recommendations drawn for determining economic limits of time, depth and spacing. This discussion, presented before the 11th Annual Secondary Recovery Conference, State College, Pennsylvania, sets up formulae which, applied to meet reservoir conditions, will determine profit or loss under chosen field conditions.

THE determination of optimum well spacing in a given area for secondary recovery by water flooding, is, in general, based upon the experience in that area and may involve fairly costly errors before arriving at the correct spacing. In some cases the optimum spacing may not be used since the field experimentation required to determine it is costly and it is simpler to apply the experience gained in other areas even though this may be unwarranted because of differences in conditions. Since field experimentation is costly, it would be highly desirable to have a method available which would be based upon a knowledge of the reservoir and its fluid contents and enable an operator to calculate the optimum spacing.

This study considers the different factors which affect spacing and attempts to combine them mathematically so as to arrive at some quantitative answer. In view of the complexity of the problem, because of the large number of variables involved, it is necessary to make certain simplifying assumptions which will be indicated as the discussion develops. Because of these assumptions the result may be an approximation but one based upon the reservoir properties and therefore fairly close to the optimum.

While certain geological factors are very important in spacing considerations, some will have to be disregarded because it is not possible to place them upon a quantitative basis. For example, the presence of lenses of sand within the reservoir, which are sealed off from the main sand body by impervious or relatively impervious boundaries, will result in the loss of oil if the horizontal dimensions of such lenses are less than the order of the distance from input to producing well. However, the dimensions of such lenses would not be constant and would be unknown before wells are drilled so that they could not be taken into consideration in determining spacing. For the purpose of analysis it will be necessary to assume that the reservoir is of constant thickness, uniform character, and continuous from well to well.

The spacing in a water-flood development should be chosen so as to yield the maximum profit and all variables, both controllable and uncontrollable, should be considered toward this end. Since the problem is chiefly an economic one it is a matter of income vs. expenditures. The chief factors to be considered:

1. Ultimate oil recovery.
2. Time limit for flood completion.
3. Development and operating costs.

Ultimate Oil Recovery

The ultimate yield of oil from a given area is a measure of the income derivable from it and consideration should be given to the effect a change in spacing may have on this factor. The possible effect of spacing on lensing and therefore a loss of oil already has been mentioned, but since it cannot be evaluated, it will not be considered. The effect of spacing on the ultimate oil recovery in a uniform sand should be considered. Work on the flooding of cores in the laboratory and the analysis of field data have indicated divergent effects with respect to higher flooding pressures. In some instances no improvement in recovery over that at low flooding pressures is shown while in others there was a beneficial effect. The process does not seem to be very well understood and in view of its controversial nature, recovery will be considered to be independent of spacing in this analysis.

TABLE 1
Comparison of "Break-Even" Spacing for Different Conditons

AREA	Mode of Production	"Break-Even" Spacing
Bradford.....	Pumping	178 feet
Bradford.....	Flowing	144 feet
Mid-Continent	Pumping	430 feet
Mid-Continent	Flowing	240 feet

TABLE 2
Comparison of Pumping and Flowing Operations

Type of Production	Ten Year Flood-out Spacing	Gross Profit per Acre
Pumping.....	430 feet	$3650
Flowing.....	350 feet	5400

It will be necessary to know the recoverable oil from the area, and to arrive at this figure the saturation prior to flooding and after flooding will be needed. In regions where the sand permeability is relatively low, such as in the Bradford field, coring makes possible a determination of the oil in place. With higher permeabilities, the core may be flushed to various degrees by the drilling water so that oil saturations have very little meaning. One approach to obtaining such data is based on the following assumptions:

1. The reservoir was originally 100 percent liquid saturated.

2. The connate water content can be determined: (a) by coring with an oil base mud; (b) measurement of the irreducible minimum saturation by the capillary pressure technique; or (c) from the equilibrium water saturation on relative permeability tests.

3. Fairly accurate oil production figures are available for the area and these can be calculated back to the original reservoir conditions.

4. The areal extent, thickness, and porosity of the reservoir are known.

With the above information, a material balance computation can be made to give the oil saturation of the reservoir.

The residual saturation to be attained at the end of the water flood can be ob-

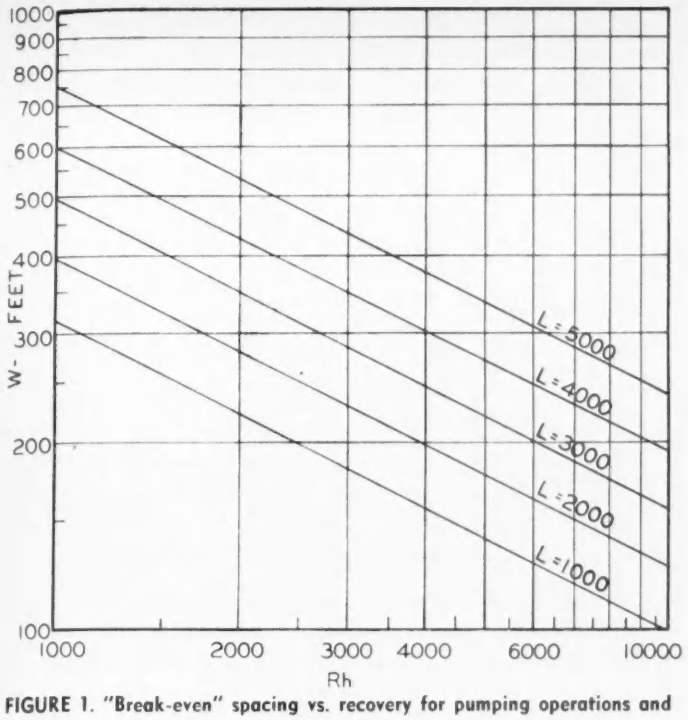

FIGURE 1. "Break-even" spacing vs. recovery for pumping operations and $4.50 oil.

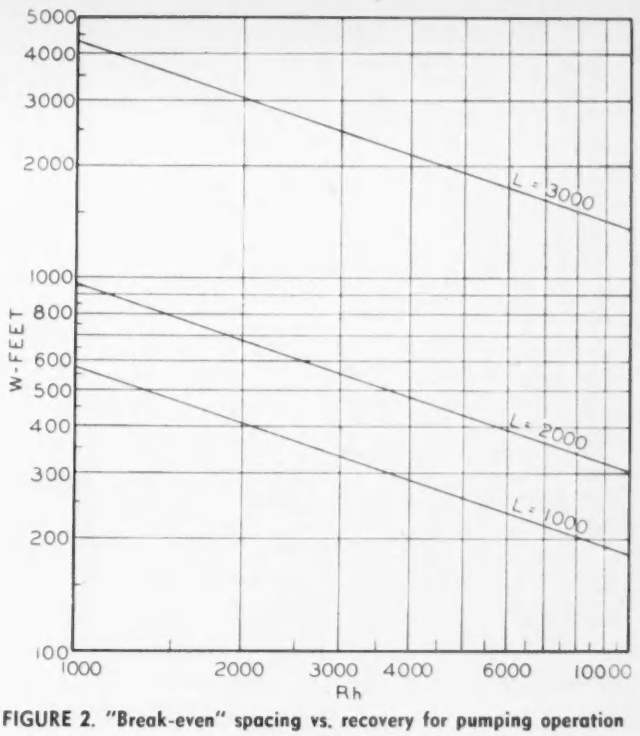

FIGURE 2. "Break-even" spacing vs. recovery for pumping operation and $1.80 oil.

tained from the results of floods in an area either by a calculation or from a core obtained in a flooded-out area. If these data are not available, a flood pot test should be made at a high pressure gradient, preferably on a virgin core from the area or on a core artificially saturated with brine and crude oil. The residual oil saturation obtained can be assumed to be the oil saturation after a field flood. The equilibrium oil saturation obtained from relative permeability data also may be used in some cases.

The difference between the oil content prior to and after water flooding is obviously the oil recovery. It should be calculated in barrels per acre foot or barrels per acre.

Development Cost

In this study the development cost will cover the expenditures for drilling, completing, and equipping both input and producing wells. The average cost of a water input well will include its proportionate share of the distribution system but will not include any portion of the water pressure plant or water supply system. The average cost of a producing well will include its proportionate share of all pumping equipment, oil and gas lines, and any other equipment required to operate these wells.

From a study of data obtained from several companies operating water floods in the Bradford area, it was found that the well cost data could be broken up approximately into a fixed charge plus a cost based upon footage. The range of footage was fairly small but in the absence of better data it will be assumed to hold in these studies. However, the development and completion methods used in other areas may change these figures to a great extent and this must be kept in mind in applying the method. Average costs were used in all cases.

The average cost of a water injection well was found to be

$$C_w = 1500 + 1.45\,L \qquad (1)$$

where L is the depth of the well in feet. For example, the average cost of a 2000-foot water well would be $4400.

The average cost of an oil producing well was found to be

$$C_o = 3000 + 1.5^{a}L \qquad (2)$$

Using the above equation, a 2000-foot producing well should average $6,000.

If the well pattern to be used in the development is the five-spot, the arithmetical average of the costs of the input and producing wells can be used as the cost per well since there would be one input well for every producing well. With other patterns the average cost per well would be weighted by the ratio of input to producing wells.

In some cases old wells are used in the pattern, which would reduce the average cost per well. One difficulty with considering the possible use of old wells in the development is that the average well cost must be considered in the determination of the well spacing and fitting of old wells into a pattern requires a knowledge of the spacing. This is equivalent to requiring an answer to the problem in order to determine the answer. A trial and error method must be resorted to.

If N equals the number of new wells needed in an area and O is the number of old wells which can be adapted to the pattern, then

$$C = \frac{C_n N + C_r O}{O + N} \qquad (3)$$

where C_n and C_r are the average cost of the new wells and the average cost of rehabilitating the old wells respectively.

Operating Cost

The operating cost in this analysis is made up of two items: (1) the cost of water delivered to the input well; and (2) the lifting costs. While cost data for both items are available, it is very difficult to choose an average value in view of the large variation possible between different areas.

In water costs, the type of water, distance of water source from pressure plant, pressure of injection and other factors must be considered. For purposes of simplification the water cost was broken into two parts; the first being the cost of producing and treating the water, and the second being the cost of delivery to the input well under the required pressure.[1,2] The equation for the delivered cost of water to the injection well per barrel is

$$D = 0.012 + 0.00000445\,P \qquad (4)$$

where P is the well head injection pressure. The first term on the right hand side of the equation is the water-producing and treating cost and the second term is the injection cost. This latter item assumes an overall efficiency of 68.5 percent and a power cost equivalent of 1 cent per kilowatt hour, which is the same as that assumed by Simmons.[1]

The average lifting cost will be computed on a per barrel of oil produced base and will be the average for the life

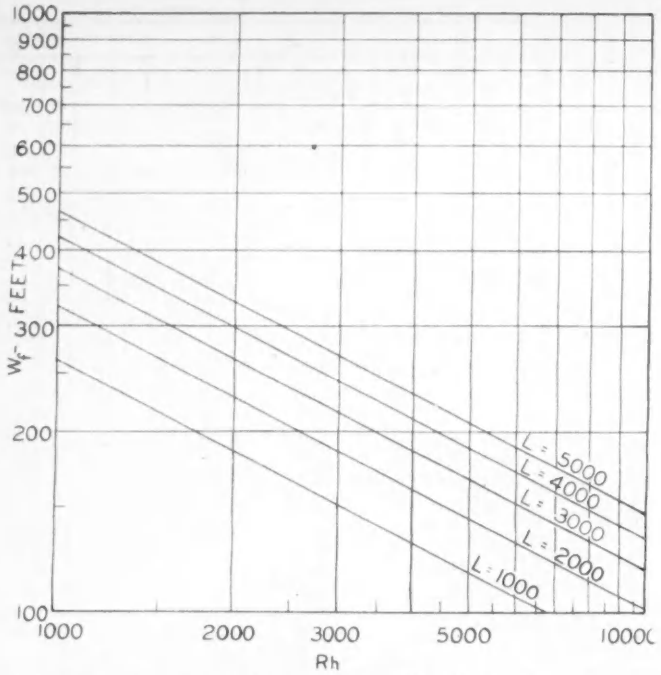

FIGURE 3. "Break-even" spacing vs. recovery for flowing operation and $4.50 oil.

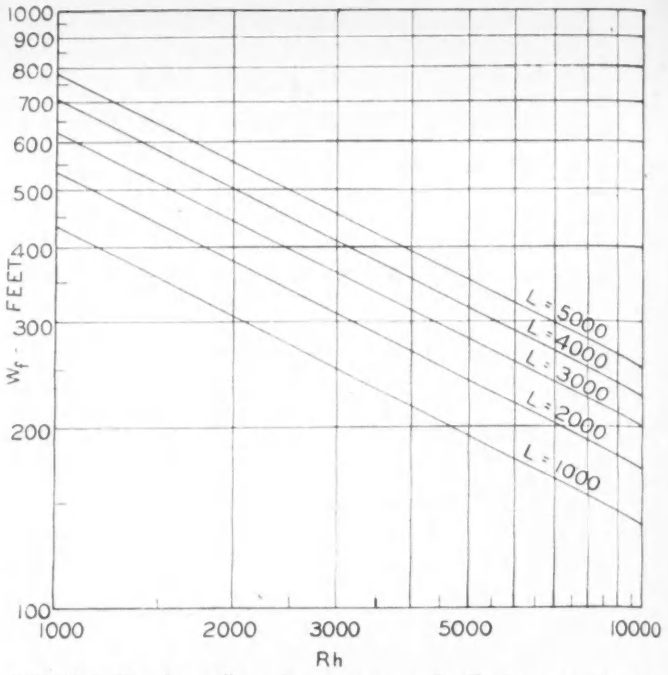

FIGURE 4. "Break-even" spacing vs. recovery for flowing operation and $1.80 oil.

of the property. It will, therefore, include the cost of lifting the water which accompanies the produced oil. This average lifting cost is one of the most difficult factors to determine and the value given here should be considered only as an estimate even though it represents the average of values from several companies. The average lifting cost based upon a barrel of oil produced is

$$B = 0.00042\ L \qquad (5)$$

The average lifting cost per barrel of oil is proportional to the well depth.

"Break-Even" Spacing

If it be assumed that pressure gradient and spacing have a negligible effect on the ultimate oil recovery, it is possible to calculate a spacing in which the costs will just be balanced by the income. This will be a minimum spacing. The calculation will be based upon a five-spot development but the method with other patterns will be similar.

The number of acres in a five-spot is its area in square feet divided by 43,560 or $W^2/43{,}560$, where W is the water to water well distance. Since there are two wells (one input and one producer) on the average in a five-spot the

$$\text{Number of wells per acre} = \frac{2 \times 43{,}560}{W^2} \qquad (6)$$

If the average cost of a well is C, the

$$\text{Well cost per acre} = \frac{87{,}120\ C}{W^2} \qquad (7)$$

The average good flood will require about 15 times as much water over its life as oil to be produced over the same period. Because of the increase in price of crude in recent years the above factor in some cases has approached a value of 20 since the abandonment time has been prolonged. If R is the average oil recovery per acre foot and h the producing sand thickness, equation (4) gives the water cost per barrel, and if the factor of 15 given above holds, the

$$\text{Water cost} = 15\ Rh\ (0.012 + 0.00000445\ P) \qquad (8a)$$

If the flooding pressure to be used is to be the maximum (prior to parting the formations) and assuming one pound per square inch downward pressure for every foot of overburden, the safe surface pressure, P would be equal to 0.57 L. Substituting this in (8a) gives

$$\text{Water cost} = 15\ Rh\ (0.012 + 0.00000253\ L) \qquad (8b)$$

The lifting cost based upon a barrel of oil produced is given by equation (5) and multiplying this by the recovery per acre will give the total lifting cost or

$$\text{Lifting Cost} = 0.00042\ L\ R\ h \qquad (9)$$

The total development and operating costs per acre would be the sum of the well cost, water cost, and lifting cost or

$$\text{Total cost} = \frac{87{,}120\ C}{W^2} + 15\ Rh\ (0.012 + 0.00000253\ L) + 0.00042\ LRh \qquad (10)$$

$$= \frac{87{,}120\ C}{W^2} + Rh\ (0.18 + 0.000458\ L)$$

To "break-even," the above figure should equal the total income derived from the sale of the crude oil. If M is the market value of a barrel of crude oil and there is a one-eighth royalty on the production, then

$$\text{Total Income} = \tfrac{7}{8}\ M\ R\ h \qquad (11)$$

This does not consider the present worth of future production since the production as a function of time is needed to make such an evaluation. By equating (11) and (10) the "break-even" conditions will be obtained.

$$0.875\ M\ R\ h = \frac{87{,}120\ C}{W^2} + Rh\ (0.18 + 0.000458\ L) \qquad (12)$$

Solving for W gives the break-even or minimum spacing

$$W = \sqrt{\frac{87{,}120\ C}{Rh\ (0.875\ M - 0.18 - 0.000458\ L)}} \qquad (13)$$

In a five-spot development, the number of input wells should equal the number of producers. The average cost per well in such a development would be the average cost of an input and producer. By averaging equations (1) and (2) the average cost should be obtained or

$$C = 2250 + 1.475\ L \qquad (14)$$

It should be kept in mind that the cost data given here are averages for the Bradford area and may be quite different for other areas. Substituting (14) in (13) gives

$$W = \sqrt{\frac{87{,}120\ (2250 + 1.475\ L)}{Rh\ (0.875\ M - 0.18 - 0.000458\ L)}} \qquad (15)$$

This gives the spacing in terms of the well depth, recovery per acre, and the selling price of the crude. Referring to equation (13), it states that the spacing varies directly as the square root of the well cost and inversely as the square root of the recovery per acre. Qualitatively this appears to be in the correct direction. For example, at greater depth, well costs are greater and spacing should be increased (all other factors kept con-

stant) to counteract the increase in cost. If well costs were to increase fourfold then the spacing should be increased twofold, or in order to maintain a constant spacing the recovery per acre would have to increase to fourfold.

Flowing Production

The analysis so far assumes that all production will be pumped. It would be of interest to consider the case when the production is flowed. There will be no lifting costs and the last term of equation (10) drops out which will make a corresponding correction in equation (13). Since the producing wells will be completed like input wells, the well cost will be given by equation (1). Making these corrections gives an equation for the "break-even" or minimum spacing for flowing or

$$W_f = \sqrt{\frac{87{,}120\ (1500 + 1.45\ L)}{Rh\ (0.875\ M - 0.18 - 0.000038\ L)}} \qquad (16)$$

A comparison will be made of the "break-even" spacing for flowing and pumping of production under Bradford conditions and also for Mid-Continent conditions. It will be assumed that the well depth is 2000 feet, the recovery per acre foot is 200 barrels, and that there are 25 feet of productive sand. The price of Bradford crude is $4.50 per barrel and it will be assumed that the price per barrel in the Mid-Continent area is $1.80. Substituting these quantities into equations (15) and (16) gives the results as shown by Table 1.

Because of the higher price for Bradford crude, a considerably closer spacing is possible than in the Mid-Continent area. Qualitatively, this is to be expected. However, the surprising result is the great difference in spacing between a pumping and flowing operation in the Mid-Continent.

Both equations (15) and (16) can be put in logarithmic form so that the log of the spacing is a linear function of the recovery per acre with all other factors held constant. Figures 1 and 2 give the "break-even" spacing for a pumping operation as a function of the recovery per acre for $4.50 and $1.80 oil respectively with well depth as a cross variable. Figures 3 and 4 represent a similar analysis for a flowing operation. For both Bradford and Mid-Continent conditions there is an apparent advantage to a flowing operation. This does not consider recovery rate and the economic factors which it controls. These will be considered later.

By dividing equation (16) into (15) it is possible to obtain the ratio of the pumping to flowing spacing.

$$\frac{W}{W_f} = \sqrt{\frac{(2250 + 1.475\ L)\ (0.875\ M - 0.18 - 0.000038\ L)}{(1500 + 1.45\ L)\ (0.875\ M - 0.18 - 0.000458\ L)}} \qquad (17)$$

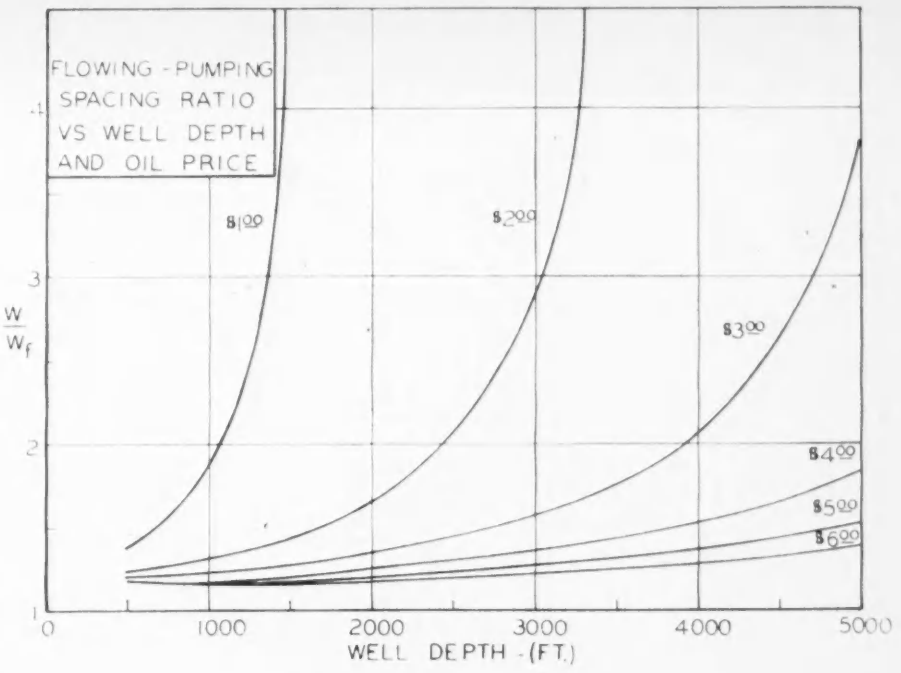

FIGURE 5

This ratio is independent of the recovery per acre since it was assumed that the ultimate recovery would be independent of method of production. The ratio is plotted as a function of the well depth with the price of crude as a cross variable in Figure 5. The higher this ratio, the less favorable the pumping operation as compared to the flowing operation. Under the assumptions made, flowing will always be more economic than pumping but Figure 5 indicates that at lower oil prices and greater well depth (equivalent to less income and greater costs), the flowing operation is especially advantageous. This presupposes that the formation will have a sufficient permeability to give an economic rate of production.

Limiting Conditions for Flooding

If the parenthetical term in the denominator of the fractions under the vinculum in equations (15) and (16) becomes zero, the spacing would become infinite. Obviously such a condition is absurd, but it would represent a theoretical limiting condition on a development. By setting the parenthetical expressions equal to zero, a limiting value of the well depth would be obtained as a function of the price of crude. This theoretical limiting depth for a pumping operation is obtained from equation (15).

$$L_{lp} = 1910\ M - 393 \qquad (18)$$

The corresponding equation for a flowing operation is obtained from equation (16).

$$L_{lf} = 23{,}000\ M - 4750 \qquad (19)$$

It should be pointed out again that these results are the theoretical maximum and the actual would be somewhat less. They also hold for the cost data and other conditions assumed.

Since equations (18) and (19) apply to the condition of infinite spacing, it is equivalent to having no wells on the property. The economic balance then would involve income from oil vs. cost of water delivered to the injection well and lifting costs. The parenthetical expressions upon which equations (18) and (19) are based represent such cost data per barrel of oil recovered. This would be the cost data for the water flooding of an old property in which no new wells are drilled and no money is spent on the rehabilitation of old wells. This is certainly the lower limit for development cost. An examination of equation (19) shows that for oil as cheap as $1 per barrel, the theoretical limiting depth is almost 20,000 feet, indicating the advantage of a flowing operation. The theoretical limiting conditions for a pumping operation as given by equation (18) are plotted in Figure 6. This gives a maximum theoretical depth at which a property can be water flooded under the conditions assumed. For example, at $1 oil the maximum depth for water flooding would be about 1500 feet.

Development of Marginal Areas

Using equations (15) and (16) it is possible to determine the effect of recovery per acre and the price of crude

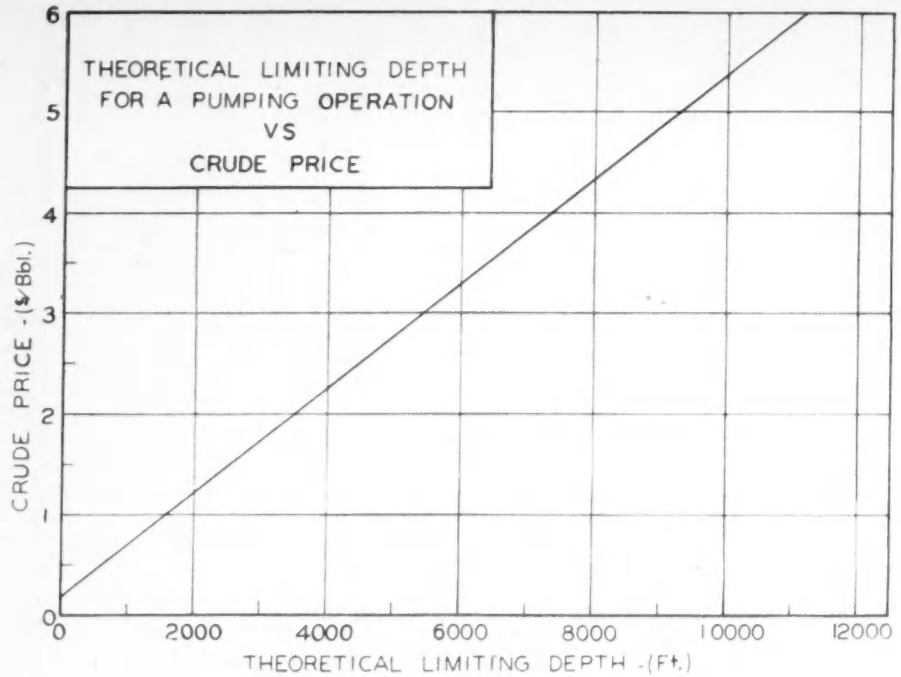

FIGURE 6

oil on the break-even spacing holding the well depth constant. It will be assumed that the well depth is 2000 feet. Figures 7 and 8 give the pumping and flowing spacing, respectively, as a function of recovery per acre and the price of crude oil. In a 300-foot, five-spot pumping operation (Figure 7) the recovery per acre for break-even at $2, $3, $4, $5 and $6 oil is 7500, 3300, 2200, 1550, and 1220 barrels, respectively. This indicates the marked effect of price on the quality of property which can be developed. Since the total recovery is the product of the recovery per acre foot and the number of feet of sand, the break-even spacing can be correlated with the minimum number of feet of sand which can be developed. In a 300-foot, five-spot flowing operation (Figure 8), the recovery per acre for break-even at $1, $2, $3, $4, $5 and $6 oil is 7000, 2850, 1800, 1325, 1020, and 880 barrels, respectively. The advantage of flowing is obvious under the conditions assumed and providing the rate of production is sufficiently rapid. At $2 oil the poorest recovery under pumping conditions which can be handled in a 300-foot five-spot at 2000 feet is 7500 barrels per acre. The corresponding value for flowing is 2850 barrels per acre. At $4.50 oil under corresponding conditions the minimum economic recovery per acre for pumping is 1750 barrels as against 1150 for flowing. The relationships given imply that the well cost in a given area will be unaffected by the crude price. This is not true since some direct correlation does exist. However, since the relationship is not known quantitatively, this factor must be disregarded. Because of the possible economic advantages of flowing it would appear that this method of production may bring certain marginal areas into consideration and thereby increase our petroleum reserves.

The discussion so far has assumed that the maximum flooding pressure to the point of parting the formations will be used in these operations. In some areas such high pressures are not used because of the high permeability of the sand. In these cases the water cost equation (8a) is used with no substitution of 0.57L for P. The equations corresponding to (15) and (16) then become

$$W = \sqrt{\frac{87{,}120\,(2250 + 1.475\,L}{Rh\,(0.875\,M - 0.18 - 0.0000668\,P) - 0.00042\,L)}} \qquad (20)$$

$$W_f = \sqrt{\frac{87{,}120\,(1500 + 1.45\,L)}{Rh\,(0.875\,M - 0.18 - 0.0000668\,P)}} \qquad (21)$$

These relationships hold only under the conditions assumed and proper corrections should be made for other conditions. At best the results given will be approximations and should not be considered otherwise.

Flood-Out Time

The equations given so far have been based upon certain economic factors, but no consideration has been given to rate of flooding or its equivalent, the flood-out time. Obviously an increase in spacing will bring with it the disadvantage of a longer flood-out time along with certain advantages of lower development and operating cost. However, the spacing cannot be made too great since it will require too long a period of time to complete the production. In the intensive floods in the Bradford area, it is usually planned to complete the operation in about ten, or at the most, 15 years. Ten years is more desirable in that equipment repairs and other maintenance costs will be at a minimum. This time limit will be used in the analysis.

It was assumed previously that the total water required to complete the flooding operation would be 15 times the recoverable oil. Since the water required per acre would be 15 Rh and the number of acres per five-spot is $W^2/43{,}560$, the product of these would be the water required per five-spot or

$$\text{Total water per five-spot} = \frac{Rh\,W^2}{2900} = 0.000345\,RhW^2 \qquad (22)$$

The steadied rate of water input in barrels per day into a five-spot is given by the equation

$$Q_s = \frac{0.00154\,khP_b}{\mu\,(\log W/r_w - 0.420)} \qquad (23)$$

where k is the effective permeability of the formation to the flood waters in millidarcies, P_b is the sand face input pressure, μ is the viscosity of the injected water in centipoises at the formation temperature, and r_w is the effective well radius in feet. If the production is by flowing, the surface injection pressure, P, should be substituted for P_b.

Dividing the total water needed by the rate per day will give the number of days necessary to complete the flood. Since the time specified was ten years, the spacing must be so adjusted that the required amount of water will flow into the formation during the time interval chosen. Equation (22) divided by (23), set equal to 10×365, and simplified gives

$$W^2\,(\log W/r_w - 0.42) = \frac{16{,}300\,k\,P_b}{\mu\,R} \qquad (24)$$

This gives the spacing as a function of the factors controlling a ten-year flood-out time. The derivation has assumed a steadied rate of water input which is not the true situation, but it will be sufficiently accurate to approximate the spacing. Unfortunately, W cannot be solved for directly but a trial and error solution must be resorted to. In general, it will be simplest to substitute definite values of W into the equation and evaluate the left hand side. The variables on the right hand side then can be determined.

In order to use equation (24), it is necessary to know what r_w and k will be.

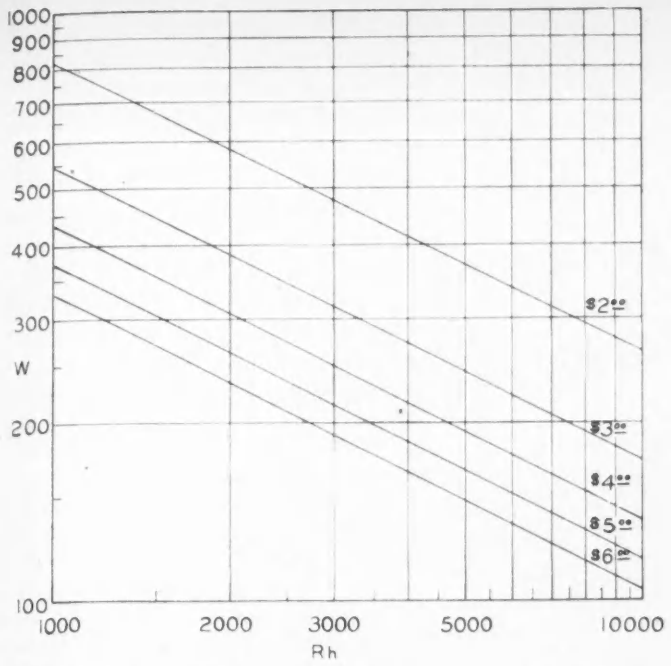

FIGURE 7. "Break-even" spacing for pumping vs. recovery and crude price for 2000-foot well.

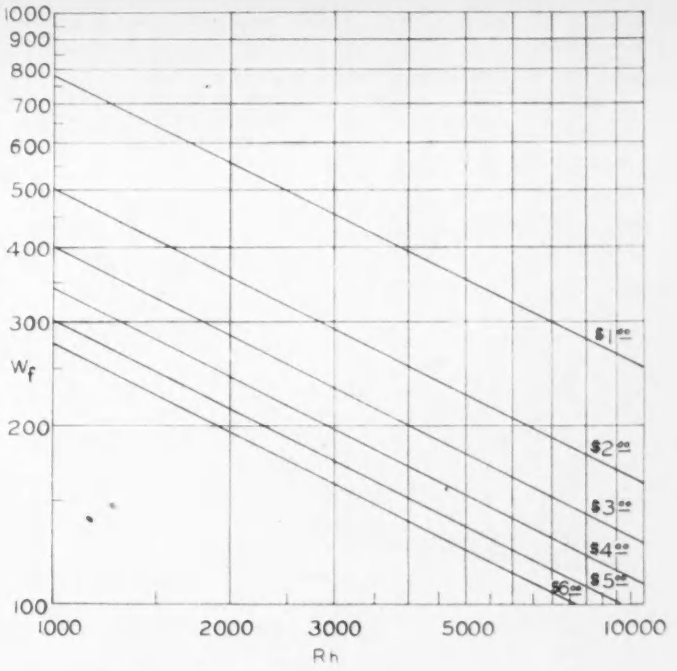

FIGURE 8. "Break-even" spacing for flowing vs. recovery and crude price for 2000-foot well.

The first is a controllable variable within limits which is determined by shooting or possibly by acidizing. The second is an uncontrollable variable which is a function of the fluid saturations in its simplest terms. The effective radius of the wells, r_w, requires a knowledge of the shot responsiveness of the sand in a given area and the size of shot used. This can be obtained only by experience in an area. No adequate quantitative test has yet been developed in the laboratory for testing sand samples for their shot responsiveness. The field method requires that several shots of varying concentration be made on a given sand and the water input data analyzed by a method described in the literature.[3] This same method also gives the effective permeability of the sand to the advancing flood waters. A laboratory method has recently been described for obtaining effective permeabilities on small core samples.[4] This can be used if field data are not available.

If the sand is made up of several strata of varying permeability, which is usually the case, some method of averaging must be used. Ideally, each permeability should have its own spacing, but since this is impossible, the various strata should be weighted according to effective permeability since that factor controls rate and also according to recovery since the latter controls the volume to be injected as specified in the initial assumptions. An additional reason for weighting the recovery is that the operator is chiefly interested in this factor and conditions should be chosen to favor the richest stratum. Accordingly, the following weighting equation is recommended for obtaining an average k to use in equation (24):

$$\frac{\Sigma khR}{\Sigma bR} = \overline{k} \qquad (25)$$

In order to indicate the effect of the variables in equation (24) on the spacing, Figure 9 was plotted with the spacing versus permeability and the recovery per acre foot as a cross variable. A sand face pressure of 2000 psi, a viscosity of one centipoise, and an effective well radius of 15 feet were assumed.

It would be of interest to apply the graph to Bradford conditions and determine the spacing. Assuming the permeability to be five millidarcies and the relative permeability to be one tenth, the effective permeability would be 0.5 md. Let the recovery per acre foot be 200 barrels. The spacing under these conditions should be about 300 feet, which is of the order used in Bradford. If the recovery had been 100 barrels per acre foot, the spacing would have been 400 feet.

For higher permeabilities the spacing is correspondingly increased. For an effective permeability of ten md. and the same conditions as given previously, a 1100-foot spacing appears to be in order. This is considerably above what is used for these conditions in the Mid-Continent area. One reason for this is that lower pressures are used in order to hold down the volume rate of injection. According to equation (24), a reduction in flooding pressure will require a reduction in spacing in order to attain a ten-year flood-out time. The substitution of a shorter spacing and lower flooding pressure for the maximum spacing and maximum flooding pressure may be valid for holding to a ten-year flood-out time but it may not be advisable economically. The cost of the additional wells necessary with a reduced spacing will more than offset the saving involved in injecting water at lower pressures.

Since the cost calculations on water injection are based on well head pressures, it will be necessary to substitute the sum of the well head pressure and hydrostatic head for the sand face pressure in equation (24)

$$\frac{W^2 (\log W/r_w - 0.420) = 16{,}300\, k\, (P + 0.43\, L)}{\mu R} \qquad (26)$$

The approximate maximum value for P is 0.57 L to prevent pressure parting.

If the flood-out time is to be for some period other than ten years, equation (26) becomes

$$\frac{W^2 (\log W/r_w - 0.420) = 44.6\, Yk\, (P + 0.43\, L)}{\mu R} \qquad (27)$$

where Y is the flood-out time in years.

In order to show the effect of well radius on spacing, calculations were made assuming a 2000 pounds per

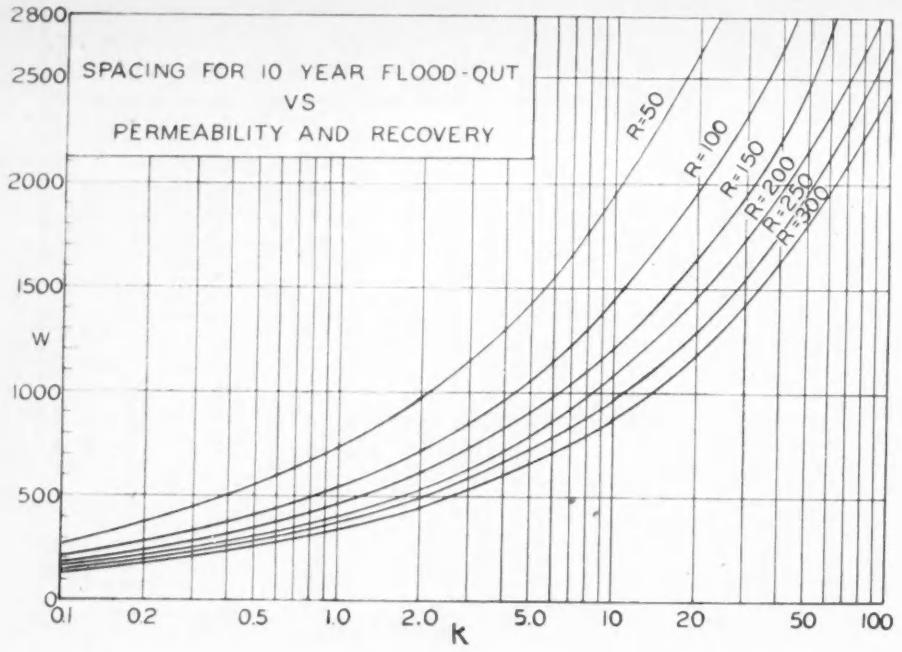

FIGURE 9

square inch flooding pressure and a recovery of 200 barrels per acre foot. The results are given in Figure 10 in which spacing is plotted against well radius with effective permeability as a cross variable. The range of well radius values goes from 0.25 feet (an unshot well) to 25 feet for a heavily shot well. This upper value has been found in the analysis of some field data from the Bradford area. For a sand having an effective permeability in the range of 0.1 md. to one md. the spacing variation is approximately 440 feet. The expense of the shot is small as compared to the added cost for additional wells needed when they are unshot.

An examination of equation (24) shows that all of the independent variables other than r_w are on the right hand side of the equation as a product quotient combination. Since the viscosity of the injected water is fairly close to one, it should be possible to plot the ratio $k P_b/R$ versus W with r_w as a cross variable. This has been done in Figure 11. By computing the ratio and choosing the proper value of r_w, the ten-year flood-out time will be obtained. Assume that a property is to be flooded at 1000 psi pressure, the recovery will be 200 barrels per acre foot and the effective permeability is two md. What will be the spacing if the wells are unshot; if the wells are shot to an effective radius of 25 feet? The ratio $k P_b/R$ is 2.1000/200 which is equal to ten. From Figure 11 the spacing for unshot wells should be about 250 feet while that for a 25-foot well radius would be about 430 feet. It may not be possible to shoot a well to a 25-foot radius so that the shooting limitation in a given area must be known before these calculations can be made.

It would be of interest to compare the ten-year flood-out spacing for flowing with that for pumping. In the example just considered, let it be assumed that the 1000 psi flooding pressure was the maximum possible on the property. The well depth was then approximately 1000 feet. The back hydrostatic pressure on the producing well would be 434 psi. The effective flooding pressure would then be the well head pressure at the injection well or 566. With this pressure, the ratio $k P/R$ is $2 \times 566/200$ or 5.66. Referring to Figure 11 for an unshot well gives about 200 feet and for a heavily shot well the value is 350 feet.

Figure 11 can be used to determine graphically the pressure correction necessary in order to compensate for unshot wells while still maintaining a constant spacing. If a sand has an effective permeability of 2 md., will yield 200 barrels of oil per acre foot, and is being flooded at 1000 psi the ratio $k P_b/R$ is ten. For a heavily-shot well the spacing would be 430 feet. In order to maintain this spacing what must the pressure be to complete the flood in ten years if the wells are unshot? Figure 11 indicates that the ratio $k P_b/R$ at a 430 foot spacing on the $r_w = 0.25$ foot curve is 23. This is 2.3 times the previous ratio or the pressure must be increased to a value of 2.3 times the original to complete the flood in the allotted time. This is beyond what can be accomplished actually and if it were possible, the additional cost involved in injecting the water would be greater than the cost of shooting.

Gross Profit Considerations

The discussion so far has concerned itself with two spacings: (1) a break-even spacing which gives no consideration to rate of recovery or time limit for completion of the flood; and (2) a spacing based on a definite flood-out time but which does not consider costs. If the break-even spacing is greater than that for a ten-year flood-out the application of the former probably will result in equipment repairs which would be costly and the operation would result in a loss. If the two spacings are the same, it will be a break-even operation. If the ten-year flood-out spacing is greater than

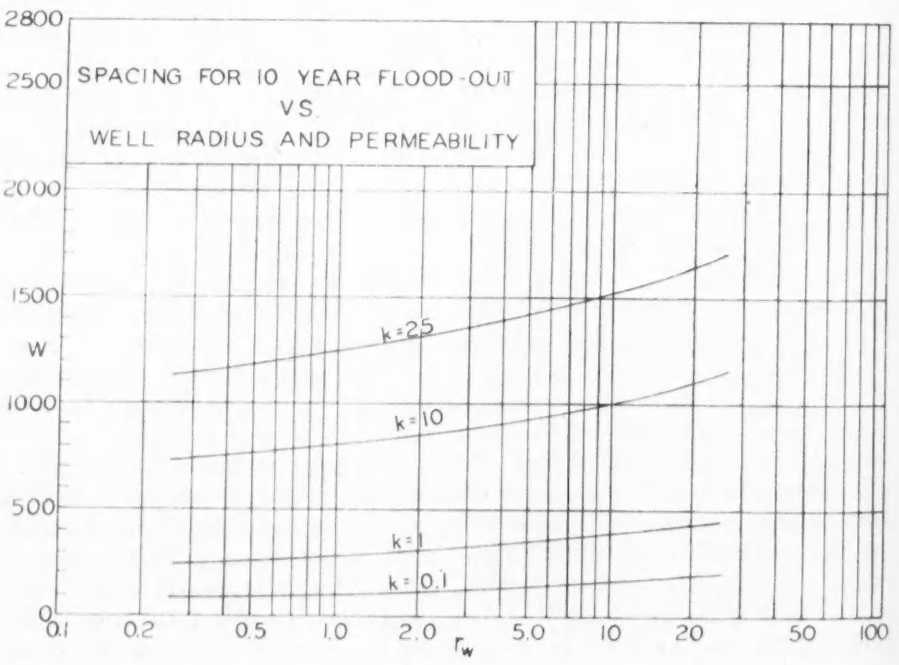

FIGURE 10

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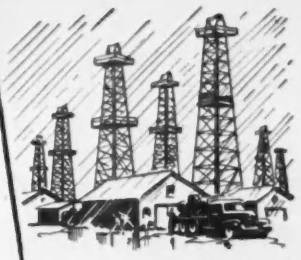

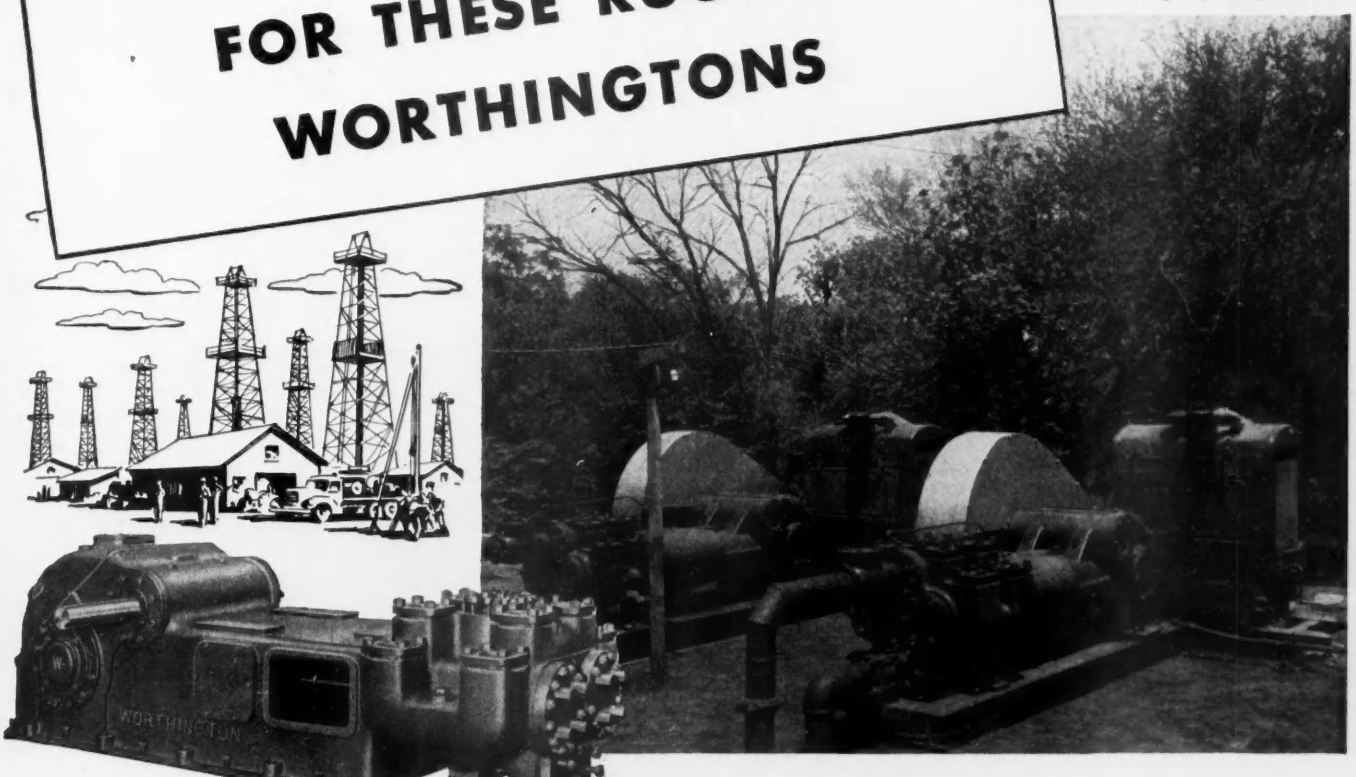

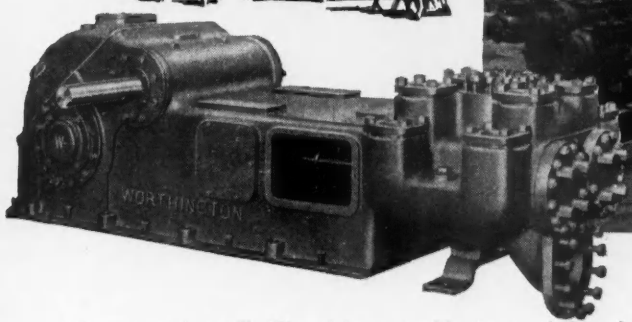

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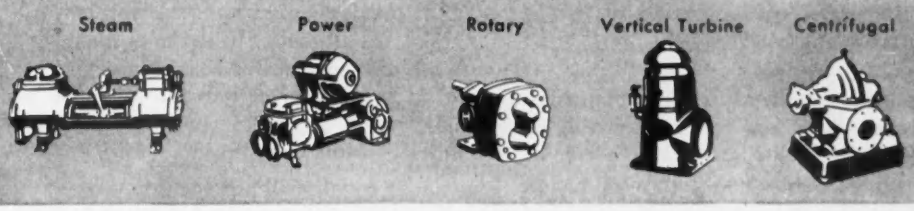

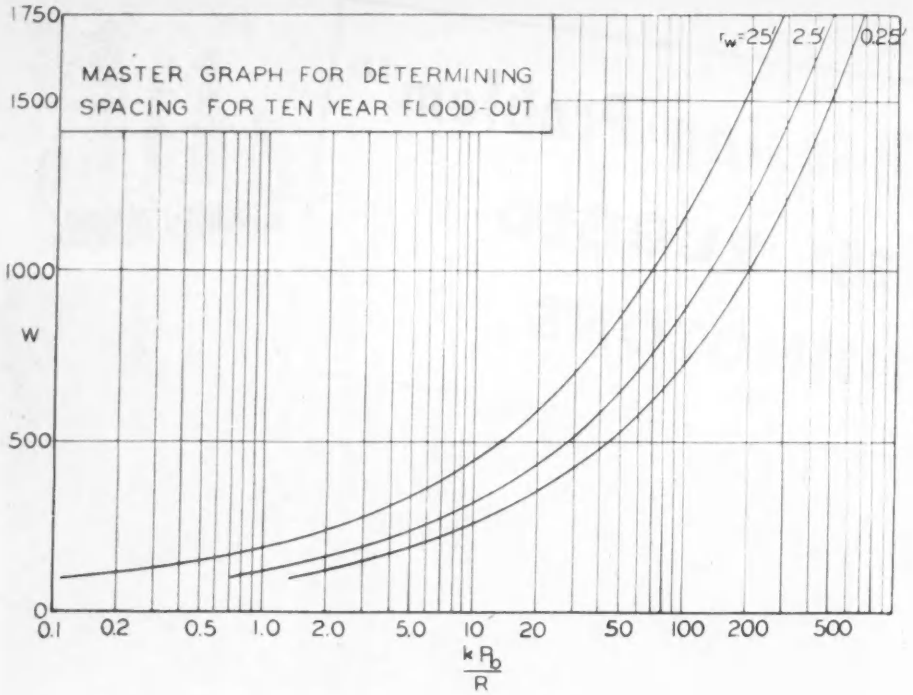

FIGURE 11

the break-even spacing, the property should operate at a profit.

Equation (12) modified to give the water cost in terms of the surface injection pressure will be

$$0.875\,MRh = \frac{87{,}120\,C}{W^2} + Rh\,(0.18 + 0.0000668\,P + 0.00042\,L) \qquad (28)$$

This equation is for a pumping operation since it contains the cost of lifting the fluids from the producing well. If it is to be used for flowing, the term containing L should be dropped. The left hand side of the equation represents the gross income on the property with no corrections for the present worth of future production. The right hand side of the equation gives a summation of the development and operating costs. The spacing W is the dependent variable which is adjusted to make the two sides equal. If W is different from the break-even spacing, the difference between the gross income and the expenditures should give the gross profit per acre or

$$G = Rh\,(0.875\,M - 0.18 - 0.0000668\,P - 0.00042\,L) - \frac{87{,}120\,C}{W^2} \qquad (29)$$

(Note that for flowing, the term containing L should be dropped.) The use of equation (26) or Figure 11 will give the ten-year flood-out spacing and this substituted in equation (29) with the other variables will yield the gross profit.

In order to illustrate the application of equation (29) a comparison will be made of the gross profit which can be derived from each, a pumping and a flowing operation. The examples cited previously will be used: 2 md. effective permeability sand, 1000 feet deep and the maximum flooding pressure used, sand thickness 25 feet, 200 barrels per acre foot recovery, and an effective well radius of 25 feet will be assumed. The crude price will be assumed to be $2.00, the average well cost in pumping will be given by equation (14) and that for flowing will be equation (1). Table 2 gives a summary of the results. The advantages of flowing over pumping under the conditions assumed are quite obvious.

Similar calculations to those already discussed can be made over a wide range of conditions. If the assumptions made do not hold for a given area the appropriate changes must be made in the relationships given. The results obtained will be approximations but will allow for a semi-quantitative approach to a solution of the problem of well spacing in water flooding.

Summary

An analysis has been made of the problem of water-flood spacing and equations for two different types of spacing derived. The first is based on an economic "break-even" of income versus cost. The second considers the conditions necessary for flood-out in a given time.

The "break-even" spacing analysis balances gross income from sale of oil against well cost, water cost, and lifting cost. It was assumed that the average flood would require 15 times as much water as oil to be produced.

The flood-out time analysis is based on the total water requirements and a steadied rate of water injection.

The "break-even" spacing can be obtained as a function of well depth, recovery per acre, price of crude, and the surface flooding pressure.

The flood-out time spacing can be obtained as a function of the effective well radius, the effective permeability of the sand, the recovery per acre foot, the well depth, and the applied surface pressure.

A relationship was obtained for computing the gross income on a development.

If the flood-out time spacing is greater than the "break-even" spacing there will be a gross profit on the operation.

Applying the spacing relationships to a comparison between pumping and flowing of the production indicates a considerable advantage of the latter.

From the results summarized it would appear that some water flood projects may be underspaced and an increase in gross porfit would be possible with an increase in spacing.

The substitution of a decreased spacing for pressures below the maximum may result in a reduction in gross income.

The substitution of decreased spacings and/or increased pressures (which are limited) for shooting appears in general to be uneconomic.

The use of the flowing method of production using the maximum possible economic flood-out time should be given consideration in the development of marginal areas. It is believed that the technique will increase the reserves of oil available by water flooding.

A relationship was derived for approximating the maximum depth at which water flooding can be carried out.

Acknowledgments

The help of A. C. Simmons, Smith-Newton Oil Company, and of South Penn Oil Company has been invaluable in obtaining cost and other data pertinent to field operations in the Bradford area. The writer also wishes to acknowledge the suggestions and criticisms of members of the petroleum production research staff of The Pennsylvania State College and the support of the Pennsylvania Grade Crude Oil Association in a portion of this work.

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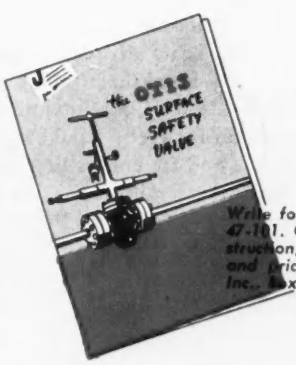

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Condensate PRODUCTION AND CYCLING

Part 12

Composition of Cycled Production

By PARK J. JONES
Consultant

THE butanes plus in production are less after a certain degree of contamination by dry gas than they would be if cycling were stopped sooner and production were by expansion. The ultimate condensate recovery is comparatively less and the operating expenses are comparatively higher for over-cycled reservoirs. Composition of production and volume of produced gas for cycling are compared here with the corresponding values for expansion as a background on when to stop cycling.

Composition for Cycling

The curves in Figure 12-1 show a wide range of composition and cumulative liquid recovery for cycling operations. The data are aside from any condensation in reservoirs. The curves with the 0.1 subscript are for a 10 percent breakthrough of dry gas and those with the 0.5 subscript, for a 50 percent breakthrough. The X curve gives the composition of the composite production from five wells having 10, 20, 30, 40 and a 50 percent breakthroughs, respectively. The wells are produced at rates which are proportional to the per-well initially in place rich gas within the per-well invadable acre-feet of pay.

Breakthrough is not identical as a rule for all wells producing from a given reservoir. The X and C curves, which are in line with average field experience, will be used for the purpose of comparing the going and ultimate liquid recovery by cycling with the corresponding values for expansion. The comparisons are in terms of the rich gas initially in place within the invadable acre-feet of pay. Where a portion of a reservoir is not invadable by dry gas, corrections should be applied so as to place expansion and cycling data on a comparable basis.

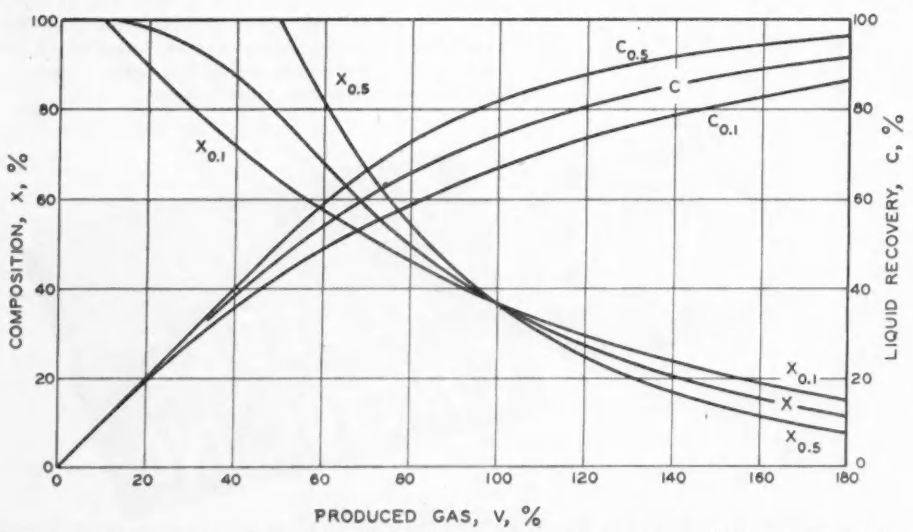


FIGURE 12-1. Composition X and Cumulative liquid recovery C from five wells produced at rates proportional to per-well initially in place rich gas and having 10, 20, 30, 40 and 50 percent breakthrough respectively.

Expansion vs Cycling for Gas A

Gas A contains 27.8 barrels of butanes plus per million cubic feet. The dew-point pressure is 3870 pounds per square inch absolute at 212° F. If this gas were produced by expansion, no water encroachment, the composition of production and cumulative liquid recovery would be defined by the X_e and C_e curves in Figure 12-2. A decline in reservoir pressure from 3870 down to 600 psia would yield 85 percent of initially in place gas and about 76 percent of the liquid. The gas and liquid recovery by expansion plus some displacement by encroaching water would be higher. All the residue gas after shrinkage, fuel and losses would be available for utilization.

On the other hand, suppose gas A were cycled at, or above, dew-point pressure. On the basis of average field experience as to breakthrough of dry gas, the composition of production and cumulative liquid recovery would be defined by the X_d and C_d curves in Figure 12-2. The data are as follows:

Composition, %	50	40	30	20
Barrels per million	13.9	11.1	8.3	5.6
Liquid recovery, %	65	72	79	86
Produced gas, %	79	94	123	143

Expansion vs Cycling for Gas B

Gas B contains 50.2 barrels per million at 4660 psia dew-point pressure and 220° F. The composition and cumulative

liquid recovery by straight expansion are defined by the X_e and C_e curves respectively in Figure 12-3. Aside from water encroachment, expansion down to 600 psia would yield 87 percent of in place gas and about 66 percent of the liquid.

The X_d and C_d curves in Figure 12-3 are for cycling at, or above, dew-point pressure. The following points may be of interest:

Composition, %	30	20	15
Barrels per million	15.0	10.0	7.5
Liquid recovery, %	79	86	89
Produced gas, %	118	142	163

In this example, cumulative liquid recovery is 66 percent by the time the gas is cycled down to 24.6 barrels per million. A cycling economic limit of 15 barrels per million would recover 12 percent more liquid than expansion down to 600 psia.

Expansion vs Cycling for Gas C

Gas C contains 135.9 barrels per million at 4490 psia and 200° F. The composition and cumulative liquid recovery by expansion alone down to 600 psia are shown in Figure 12.4. Aside from water, the yield of gas would be 86 percent and of liquid, 60 percent.

The X_d and C_d curves for cycling give the following points:

Composition, %	30	20	10
Barrels per million	40.8	27.2	13.6
Liquid recovery, %	78	86	92
Produced gas, %	113	142	190

Cumulative liquid recovery is 60 percent when the composition of cycled production is about 68 barrels per million. A cycling economic limit of 13.6 barrels per million would recover 32 percent more liquid than expansion down to 600 psia.

Fifty Percent Injection Rate

Suppose the volumetric rate of dry gas injection equals 50 percent of the volumetric rich gas producing rate. Aside from water encroachment, reservoir pressure would decline down to about 10 percent of dew-point pressure at the time cumulative gas production is 180 percent of initially in place rich gas. For this condition, 50 percent of the producing rate less shrinkage, fuel, losses and differences in compressibility factors between produced and injected gas would be available for sales.

The approximate composition of production for the B gas is given by the X_{de} curve in Figure 12-5. The X_d curve is the composition aside from condensation, that is, the volume percent rich gas in production after contamination by dry gas. The X_e curve shows the composition of the rich gas after condensation. The X_{de} curve is the product (X_d X_e), that is, the approximate composition after contamination and condensation for 50 percent dry gas injection rate.

Liquid recovery by cycling, at or above dew-point pressure, down to 15 barrels per million is about 79 percent. The corresponding liquid recovery by cycling at a 50 percent injection rate would be about 62 percent. Reservoir pressure would be between 30-35 percent of dew-point pressure aside from water encroachment. Compressors would be required on the upstream side of a plant if plant throughout were to remain at a uniform rate. A retrograde gas which is richer than the B gas would have a comparatively greater loss by condensation for a 50 percent injection rate.

Condensation While Cycling

The volumetric rate of gas injection after shrinkage, fuel, losses and correction for compressibility at reservoir conditions may be anywhere from 80 up to 95 percent of the volumetric rate of withdrawal. The richer the gas, the greater the difference between volumetric producing and injection rates.

Suppose the volumetric rate of gas injection were 80 percent of volumetric producing rate for gas C. Aside from water encroachment, the reservoir pressure would be about 80 percent of dew-point pressure at the time produced gas equals 100 percent and about 67 percent when produced gas is 1.8 volumes. The X_e curve in Figure 12-6 shows the composition of the in place rich gas. The X_d curve defines the rich gas in

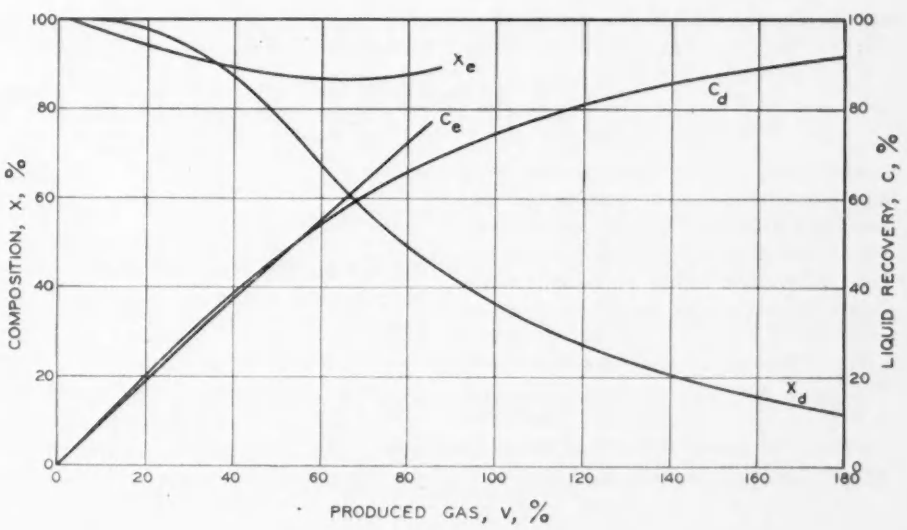


FIGURE 12-2 (above). Composition, liquid recovery and volume of produced gas for retrograde gas A; d refers to displacement at 3870 psia; e refers to expansion from 3870 to 600 psia and no water encroachment.

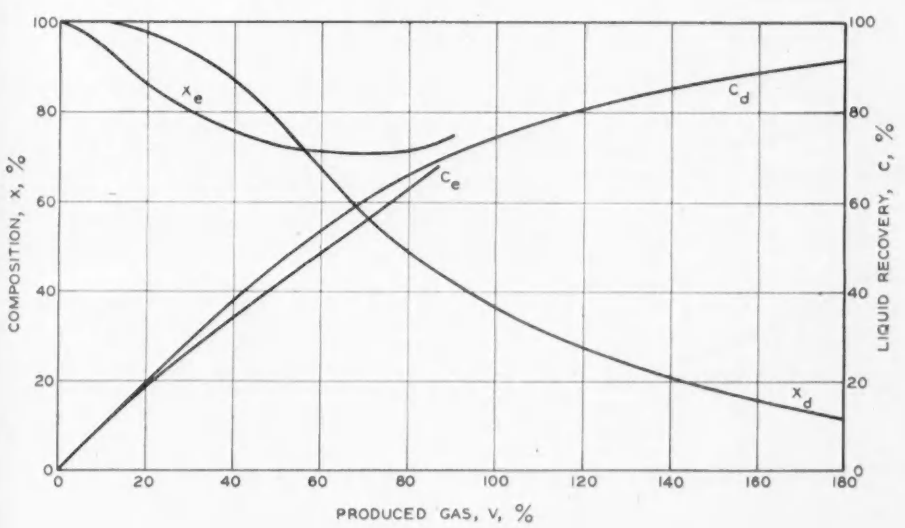


FIGURE 12-3 (left). Composition, liquid recovery and volume of produced gas B; d refers to displacement at 4660 psia; e refers to expansion from 4660 to 600 psia and no water encroachment.

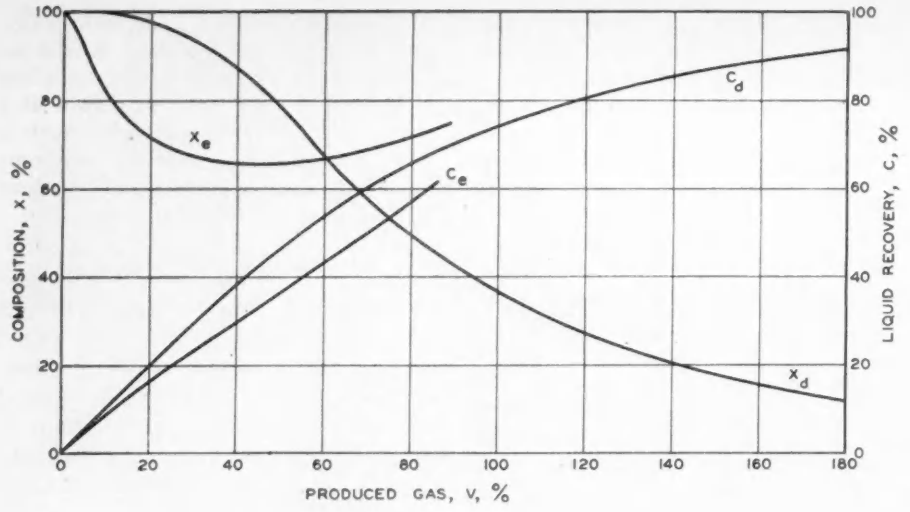
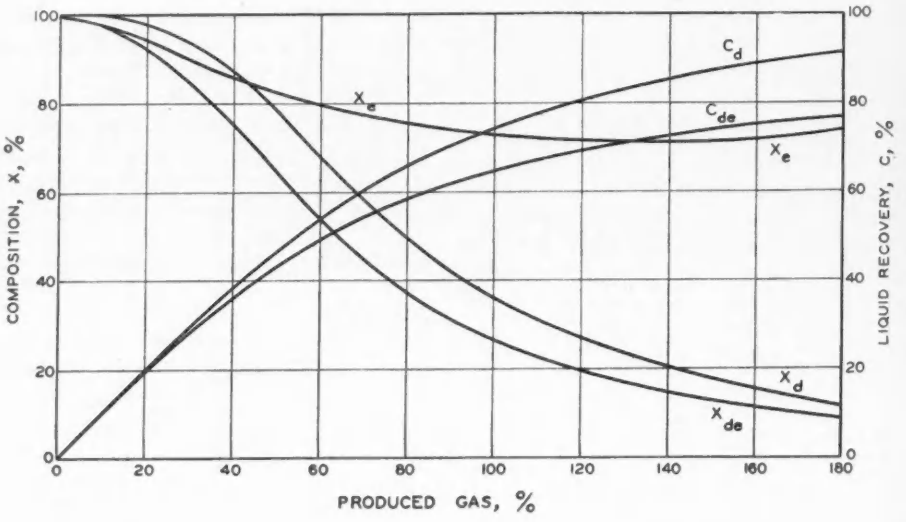


FIGURE 12-4 (left). Composition, liquid recovery and volume of produced gas C; d refers to displacement at 4490 psia; e refers to expansion from 4490 to 600 psia and no water encroachment.

FIGURE 12-5 (below). Approximate composition X_{de} and liquid recovery C_{de} for residue gas injection rate equal to 50 percent of B gas producing rate; dry and rich gas volumes measured at reservoir conditions.

production. The product ($X_e X_d$) equals X_{de} the approximate composition of production after contamination by dry gas and loss of liquid by condensation.

Evidently, the loss of liquid resulting from 80 percent injection into a very rich retrograde gas reservoir may be a significant fraction of the initial liquid content. Either water or dry gas from some other source should be injected in addition to the available residue gas. In other words, the degree of pressure maintenance should be on the order of 100 percent for large and very rich retrograde reservoirs.



Transfer of Gas

There may be no advantage in cycling a comparatively lean retrograde gas reservoir from the viewpoint of ultimate liquid recovery. On the other hand, the loss in ultimate liquid recovery from a large and very rich retrograde gas reservoir may be on the order of several million barrels for the first 10 percent decline in reservoir pressure below the dew-point. Consequently, if a lean retrograde gas is associated with a very rich retrograde gas in a given field, the reservoirs should be produced in parallel and the residue gas from the lean reservoir should be injected into the very rich reservoir.

The transfer of gas makes for a more uniform composition of production, that is, lean and very rich parallel operations have a more uniform rate of liquid production than a series operation in which rich production is followed by lean production. A uniform rate of liquid recovery is advantageous from the viewpoint of plant operations. However, the payout for a uniform rate of liquid recovery is longer than the payout for a maximum initial rate of liquid recovery. But the annual interest on the investment in a cycling project is usually small by comparison with the present value of several million barrels of liquid that may otherwise be lost by condensation.

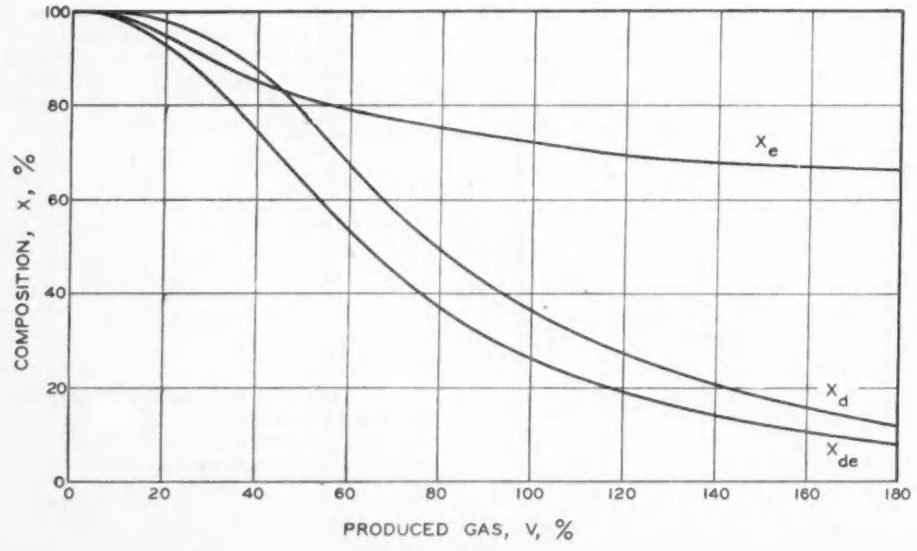
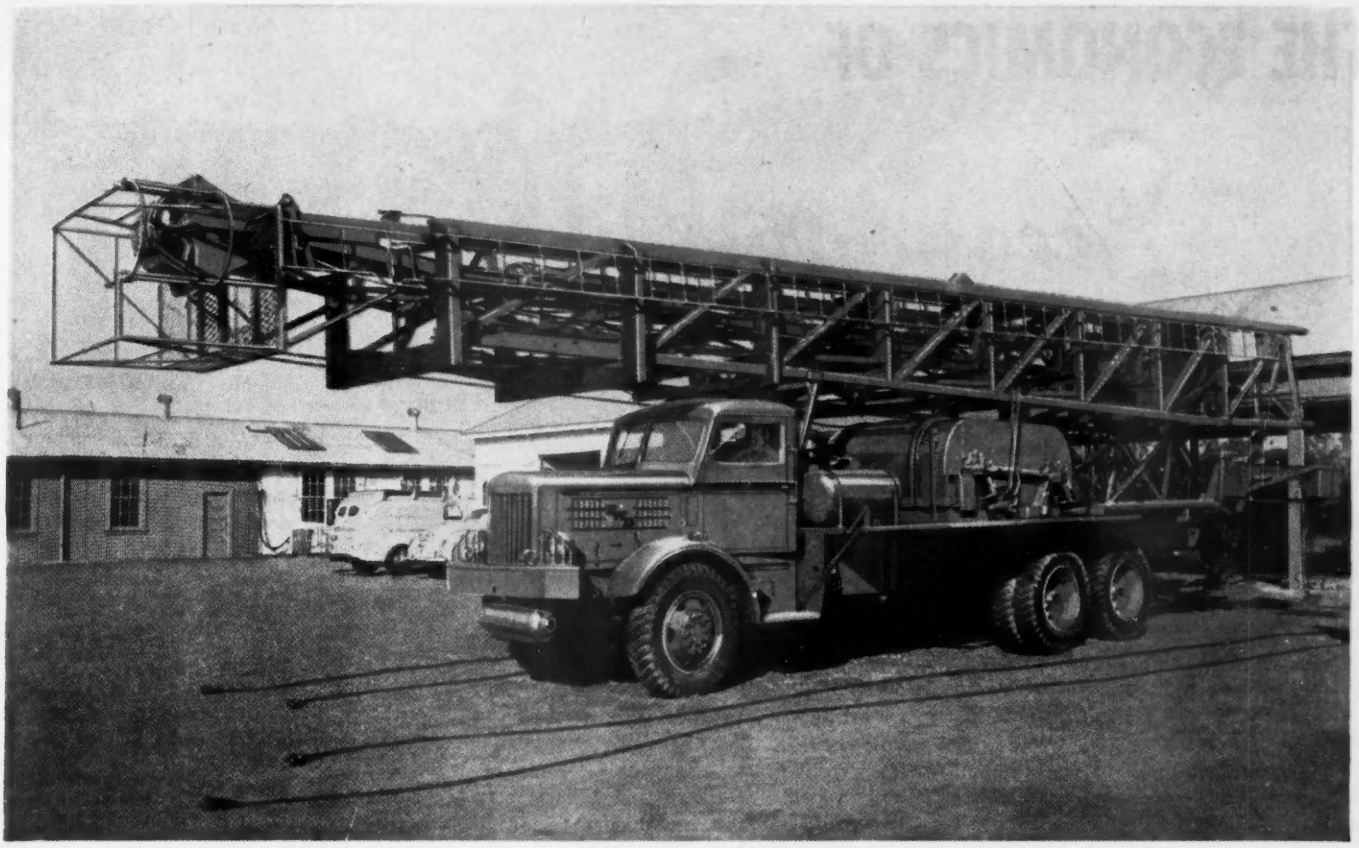


FIGURE 12-6. Approximate composition X_{de} after contamination and condensation for 80 percent volumetric injection rate of residue gas from retrograde gas C; ($X_d - X_{de}$) is loss of liquid producing rate by condensation; ($1-X_d$) is loss of liquid producing rate by contamination; X_e is the composition of in place rich gas at declined reservoir pressure.



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THE ECONOMICS OF

Secondary Oil Recovery

By W. B. BERWALD,
Study Group Leader, The Ohio Oil Company, Findlay, Ohio

THE ECONOMICS of secondary oil recovery is closely related to the economics of primary oil recovery. Industrywide, economic conditions prevalent in the primary recovery of oil control the extent to which secondary-recovery operations are, and can be, profitably applied. When the cost of finding, developing, and producing oil by primary methods is high and the price of oil is high, the economics of secondary recovery make such operations feasible.

SECONDARY oil recovery usually is defined as the oil that is recovered from a reservoir after primary-producing operations have reached an economic limit through exhaustion of the original reservoir energy. The methods employed require the injection of a gas or liquid into the reservoir in an effort to recover more of the oil from the reservoir. The economics of secondary recovery, then, is largely a balancing of the costs for such secondary-recovery operations against the value of the additional oil recovered.

Intensive repressuring or water-flooding may be defined briefly as the carefully planned application of gas or water injection on a scale sufficient to obtain maximum economic secondary-oil recoveries. All carefully planned repressuring or water-flooding operations are not designed to obtain the maximum economic secondary oil recovery, but rather a volume which conforms with the capital investment required, the risk involved, the profit desired, and many other factors that might be considered by individual operators.

The economics of such operations, in general, and the extent to which secondary-recovery methods are employed industry wide, are so closely related to conditions prevalent in the primary recovery of oil that any consideration of the former must, of necessity, also involve the latter. Economically, the justification of secondary oil recovery originates and arises from conditions prevalent in the primary recovery of oil. The economics of individual secondary recovery operations is governed by numerous factors, many of which are peculiar to the method employed and the importance of which often varies for different areas.

All factors pertaining to an individual operation are susceptible to engineering and economic investigation and analyses, which permit, in most instances, a reliable estimate of the recoverable oil and the profit to be made. The results of such investigations and analyses may determine the economics of an individual operation and its feasibility to the individual operator.

Economic Relationship Between Primary and Secondary Recovery

The extent to which secondary recovery operations are employed in the production of oil is governed almost entirely by economic conditions in the oil industry as a whole. With few exceptions, an individual or company undertakes a secondary oil recovery operation because certain conditions, either local or industry wide, make it feasible and desirable economically to do so. Inasmuch as on a nationwide basis the volume of oil produced by secondary recovery operations is small compared with that produced by primary operations, the economics of secondary recovery operations is, to a great extent, controlled by the economics of primary recovery operations. In general, the same economic factors may be said to affect both types of operations, and that the economies of the two types of operations are closely related.

To illustrate the relationship between the economics of primary and secondary recovery and its significance in the economics of secondary recovery, the production of Pennsylvania-grade crude might be used as an illuminating example. The excellent and desirable qualities of this crude and its proximity to centers of large consumption of petroleum products have been responsible for crude price schedules approximately double those for Mid-Continent crude of like gravity. If it were not for the relatively greater demand and favorable price for Pennsylvania-grade crude, it is doubtful whether production could be maintained on any substantial scale, even with the application of the most efficient secondary recovery methods. The total production of this grade of crude is approximately 60,000 barrels per day, and represents only about 1 percent of the total crude output of the U. S. It is estimated that more than 75 percent of the Pennsylvania-grade crude is produced by secondary recovery operations.

Such operations are costly, exceeding like costs for the primary recovery. The net return is far less than similar returns from the primary recovery operations. The special qualities of this crude, and the resulting demand for it in the face of limited supplies, justify the higher posted price in competition with other crudes. The purchasers and consumers of this crude, however, are not interested in the fact that the crude is obtained largely by secondary-recovery operations. The demand, if not the price, would be the same regardless of whether the crude was obtained by secondary recovery or primary recovery, because the quality is the same under both operations. The principal reason why most of the Pennsylvania-grade crude is produced by secondary recovery operations is that it is the only way the demand can be met. Primary recovery operations in the area where this type oil is found have reached a point where it would be impossible to meet the demand for this type of crude by primary methods. In the absence of secondary recovery methods, it is doubtful that prices for such crude could attain a level high enough to justify primary recovery operations. Before prices for Pennsylvania crude reached such a level, refiners and consumers would meet their requirements

Preprint, subject to correction, of paper for presentation to a Division of Production group session on secondary recovery, before the 27th annual meeting of the API, Stevens Hotel, Chicago, November 12, 1947.

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from another source. Thus, it is seen that the economics of primary recovery operations in this area is largely responsible for the magnitude of secondary recovery operations in the area. In other words, if the total cost of producing sufficient oil in this area by primary operations was low, secondary recovery operations would not, and could not, be employed to meet the demand.

The same factors and conditions that have resulted in the extensive use of secondary recovery in the Pennsylvania grade area control the extent to which secondary recovery operations are employed in any particular area, or even on an industrywide basis. The factors controlling or affecting economic conditions in the primary recovery of crude in a given area and nationwide are numerous and varied, and it is not the purpose of this discussion to consider such factors and how they might affect economic conditions in the primary recovery of oil. The economic conditions prevalent in the primary recovery of oil, however, are important in any consideration of the economics of secondary recovery.

In many fields of the Mid-Continent and other areas, economic conditions prevalent in primary-recovery operations make the economics of secondary recovery favorable even though the quality of the oil has no particular advantage similar to Pennsylvania grade. Industrywide, the same general relationships between primary and secondary recovery economics exist; i.e., industrywide, so long as the demand for crude can be met by primary recovery operations at low costs, the economics of secondary recovery are relatively unfavorable. As the cost of primary recovery operations increases or as such methods find increasing difficulties in meeting the demand, the economics of secondary recovery operations becomes more favorable. To illustrate this relationship and to indicate its current trend, a few statistics should be helpful.

During periods of great discoveries like East Texas, Seminole, Oklahoma City and other large fields, the finding cost for new oil is low, and the price of oil usually reflects this low cost—which may be only a few cents per barrel or less. As it becomes more difficult to find new oil, the finding costs gradually rise. The average cost of finding new oil in the U. S. has increased greatly in the last several years. In 1936 it was estimated[2] to be only 5.6 cents per barrel of new oil found. For 1946 it has been estimated[3] to be 50.0 cents per barrel; and the current large amount of exploratory work, with comparatively meager results, indicates still further increases in the cost of new oil found. Regardless of the reasons and causes for this high cost of finding new oil, it is apparent that a point is reached when finding costs make up a substantial part of primary production costs. The greater the proportion of finding costs are to the total cost of primary recovery, the more favorable secondary recovery operations become. Industry-wide, this condition has become increasingly favorable to secondary recovery, and such operations are now well justified. There are many areas where the complete development cost for secondary recovery would not exceed 50 cents per barrel of oil recovered. Thus, for the average finding cost of new oil alone, it would be possible completely to develop large secondary reserves.

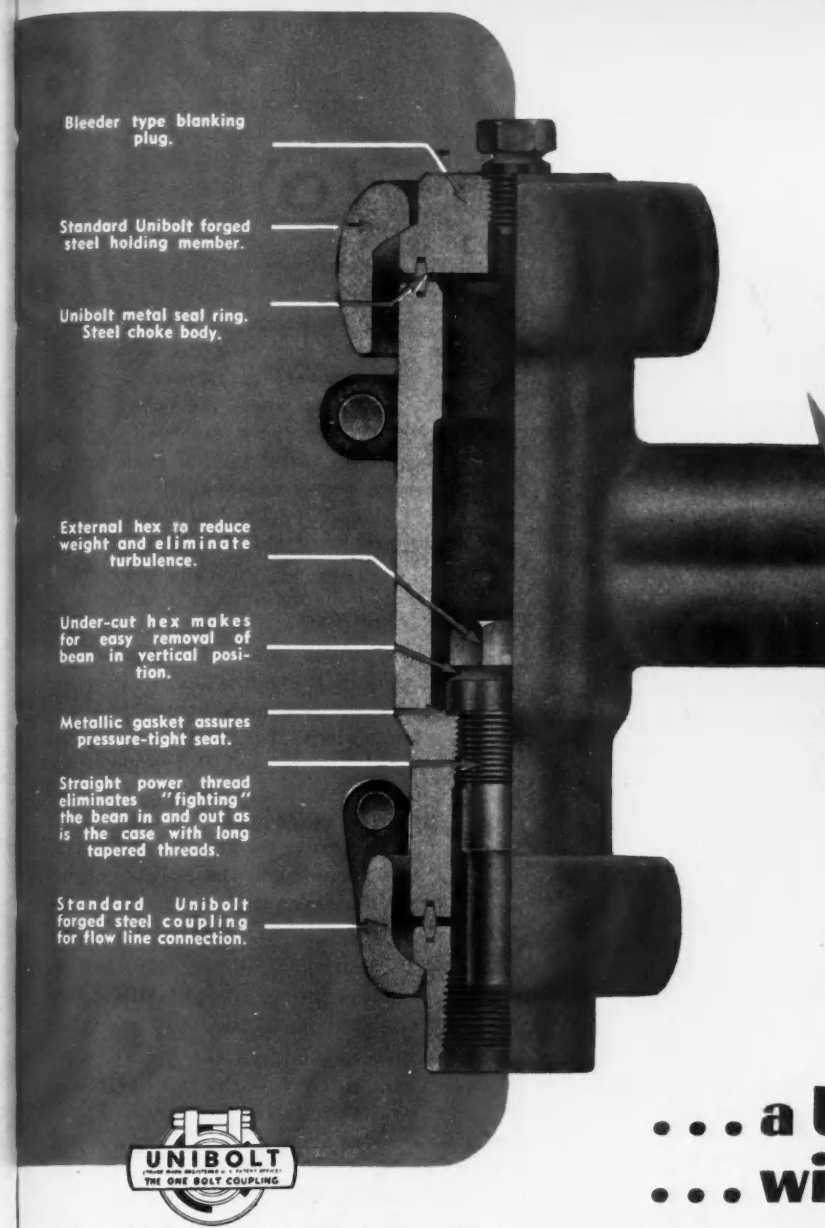
Another factor that has become of increasingly greater importance in the relationship between primary and secondary recovery economics is the cost of development of new oil reserves. At the time that secondary recovery operations were first being employed in the production of oil, the depth at which new oil reserves were being found throughout the nation was not much greater than the depth of these secondary reserves. Consequently, the development costs for intensive secondary recovery operations was, and is yet, usually greater than primary development costs at these depths. The difference in depth, between potential secondary reserves and new primary reserves, has gradually become greater and greater, until today the average depth of new primary reserves probably is in the order of 5000 to 6000 feet; whereas there are large secondary reserves still at depths that probably would not average in excess of 1500 feet. This great increase in depth for new primary reserves naturally greatly increases the cost of developing such reserves. Although these high development costs have been offset, to some extent, by wider well spacing and unit operations, they are, nevertheless, on a per-barrel-of-oil-recovered basis, exceedingly high in comparison to what they were when new reserves were being developed at much shallower depths. In 1936, it is estimated that the average development cost was approximately 20 cents per barrel; whereas in 1946, although statistics are not available, it is believed this cost will exceed 40 cents per barrel. As the trend to deeper and deeeper exploratory drilling progresses, development costs for primary recovery must increase, because the cost of drilling increases greatly with depth—and the deeper reservoirs, for several reasons, are not so productive, per acre-foot, as shallower reservoirs. It is apparent then, that, on the basis of development costs alone, an economic condition in primary recovery operations is being approached that will greatly favor secondary recovery operations.

In the relationship between primary and secondary recovery, production costs, as distinguished from finding and development costs, usually are more per barrel for secondary recovery. This difference, however, is not great, and usually is of minor importance in the economic consideration of secondary recovery operations. In 1936, the average operating cost for primary recovery operations was approximately 25 cents per barrel .By the end of 1946 these costs probably had risen to about 40 cents per barrel. These costs reflect largely the costs of labor and materials, and any change in either becomes applicable to both primary and secondary recovery operations. In primary recovery, however, a large portion of the oil is usually produced at low cost by flowing; and, as deeper and deeper primary production is obtained, the percentage recovery by flowing usually increases. Therefore, in spite of additional costs for producing equipment, as the depth of primary operations increases, the larger percentage of low-cost flowed production tends to keep these costs from rising greatly. It also keeps them well below the costs of producing by secondary recovery operations where, at present at least, not much of the oil is recovered by flowing production. Production costs for secondary recovery operations vary greatly, and statistics in this respect are insufficient to present an average.

On many old properties, in the stripper stage of primary recovery, the production costs have reached a point where the major items are labor, repair materials, overhead, and taxes. The total for

About the Author

W. B. BERWALD is a graduate of the School of Mines, University of Pittsburgh, with a degree in petroleum engineering. Formerly with the Bureau of Mines Experiment Station at Bartlesville, Okla., in charge of production research, he has been with The Ohio Oil Company since 1939, and has held his present position of Study Group Leader at Findlay, Ohio, headquarters since 1946.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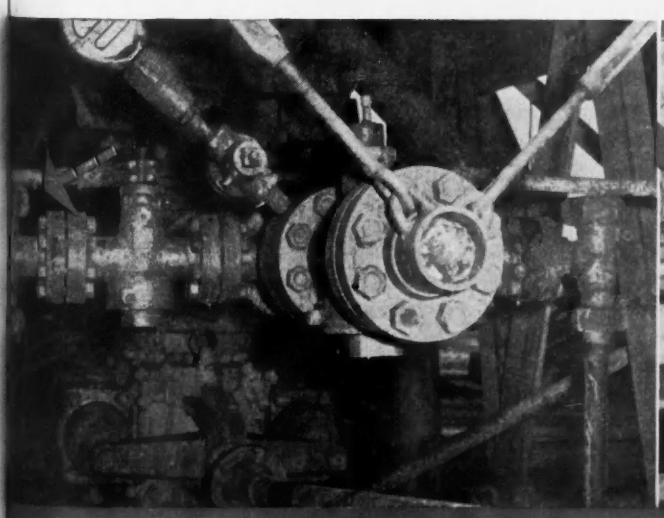

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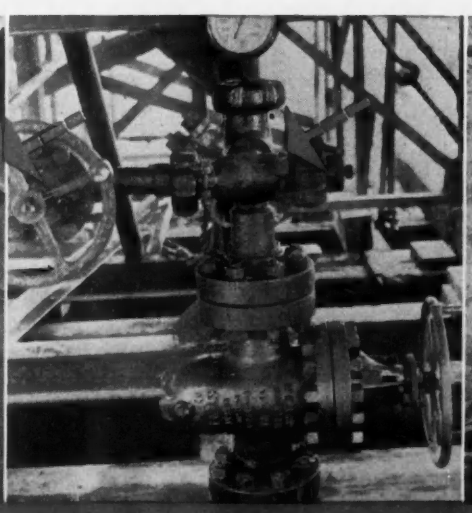

(2) A UNIBOLT Choke Body fitted with positive bean on an extremely high pressure well.

(3) A UNIBOLT Choke Body fitted with stem assembly being used as an Adjustable Wing Valve in a Christmas tree flow manifold.

these items may be $1 or more per barrel of oil produced. When secondary recovery operations are applied, much of the old producing equipment may be used and little additional operating labor may be required. Under such conditions a successful secondary recovery operation greatly reduces the per-barrel operating cost, because much of the producing equipment already has been paid for and the daily production is greatly increased. Intensive secondary recovery operations, however, may require the installation of much additional surface equipment, the replacement of most of the old equipment, and the employment of much additional labor. Under such conditions, the operating cost per barrel of oil recovered is high, and must be given careful consideration in the economics of the operation.

There can be many other factors or economic conditions prevalent in primary recovery operations in local areas that have a definite relationship to the economics of secondary recovery in those particular areas. Furthermore, different operators may be, and usually are, affected differently by a given set of conditions. The economic consideration or feasibility of individual secondary recovery operations, therefore, may and usually does, involve many and various factors other than those general factors described herein in the relationship between primary and secondary recovery. From an industry-wide viewpoint, however, the economics of secondary recovery generally may be summed up briefly in the following statement:

When the costs of finding, developing, and producing oil by primary production methods are high and the price of oil is high, secondary recovery operations become economically feasible.

Economic Factors in Secondary Recovery Operations

From the preceding general treatment of the economics of secondary recovery it is apparent that industry-wide economic conditions represent a major factor in the adoption of secondary recovery operations.

The factors of general significance that more or less in common determine the economics of individual secondary recovery operations are (1) availability or cost of the prospect; (2) probable oil recovery; (3) depth; (4) demand and price for the crude; (5) condition of primary production equipment, both surface and subsurface; (6) availability of gas for repressuring, or water for water flooding; (7) availability and cost of fuel or electric power; (8) oil-transportation facilities; (9) location; (10) size; (11) existing lease terms; (12) water-disposal facilities; (13) availability and cost for labor and field service; and (14) type of secondary recovery operations.

The order in which these factors have been listed is not necessarily in the order of their importance. Furthermore, an effort has been made to minimize the number of factors for consideration, so that the individual factors listed often represent a group of related factors—all affecting the economics of individual operators. To illustrate how this list of factors controls the economics of an individual operation, some detailed consideration of each factor or group of factors will be helpful.

All secondary recovery operations were at one time merely secondary recovery prospects. As such, they represented a certain value to the owner. This value, then, may become the first cost chargeable against the secondary recovery operation. The value of a secondary recovery prospect often is extremely uncertain, difficult to determine, and may vary greatly. In the early days of secondary recovery operations none of the present-day engineering practices had been developed, nor had secondary recovery itself been proved extensively. Under such conditions little value was placed on the secondary recovery possibilities of a property almost depleted by primary recovery operations. The value of such properties usually was determined on the basis of current oil production or the salvage value of materials and equipment in use. Even today, in areas where secondary recovery possibilities are uncertain or not extensively proved, it is common practice to evaluate stripper properties on the basis of production or salvage value. Present-day engineering and technical practices make it possible to determine with little uncertainty the probable value of many secondary recovery prospects. As a result, in areas such as Bradford, Penn., where water-flooding has been extensively proved, the value of prospective water-flooding property usually reflects a complete engineering and economic study, and is reported on an acre basis.

Regardless of methods of determination or the basis used for the evaluation of secondary recovery prospects, such values affect the economics of a secondary recovery operation. The effect of this factor is often overlooked or disregarded in considering the economics of the operation. The owner of stripper property may, in his accounting or economic considerations, place little more than salvage value on a prospect prior to development. This may be a sound procedure for the particular owner and, in general, so long as secondary recovery prospects are available on this basis. However, when it becomes necessary to purchase secondary recovery prospects, the operator soon finds out that they have a definite value which he must seriously consider in the economics of the proposed operation. Obviously, when stripper properties are considered of little more than salvage value and similar properties can be acquired on the same basis of value, the cost of acquiring desirable secondary recovery prospects under such conditions is then of no great importance, even though the true value of the prospect may be great. Desirable secondary recovery prospects become scarce in an area where the possibilities of secondary recovery are well established, and where the cost of such prospects more nearly reflect their true economic value. The Bradford field is a good example of this latter condition. In this field the cost of acquiring desirable water-flooding acreage is extremely high—in fact, almost prohibitive to the average operator interested only in the production of the oil. Thus, it is seen that secondary recovery prospects have economic values that may vary from salvage value to the values representing a major portion, if not all, of the profit that is to be made out of the development of the prospect. This value always should be included in the economics of any secondary recovery operation.

In the development of a secondary recovery operation of all the factors that affect the economics, perhaps the most important are the oil recovery per acre by secondary recovery, the demand and well-head price for the oil, and the depth to the producing formation. These three or four factors essentially control the economics of most operations, and their individual effects are so related that one can hardly be considered without the others. In most secondary recovery operations the total development costs are more or less proportional to the total acreage involved, and the costs are commonly expressed on a per-acre basis. The oil recovery per acre and the price and demand for oil control the gross income from the operation, both currently and ultimately. The development cost per acre is controlled largely by the depth. Inasmuch as development costs for intensive secondary recovery operations are high and increase with depth, it is apparent that, for a given depth, there is a minimum recovery per acre of oil for a given price that can be considered profitable. As the depth increases or the price of oil decreases, higher recoveries per acre are necessary to offset increased costs. Likewise, as the depth decreases or the price of oil increases, the minimum recovery per acre to obtain a profit decreases. These are general relationships, with other factors being equal. In any proposed secondary recovery operation, however, these factors must be considered and carefully weighed in order to determine

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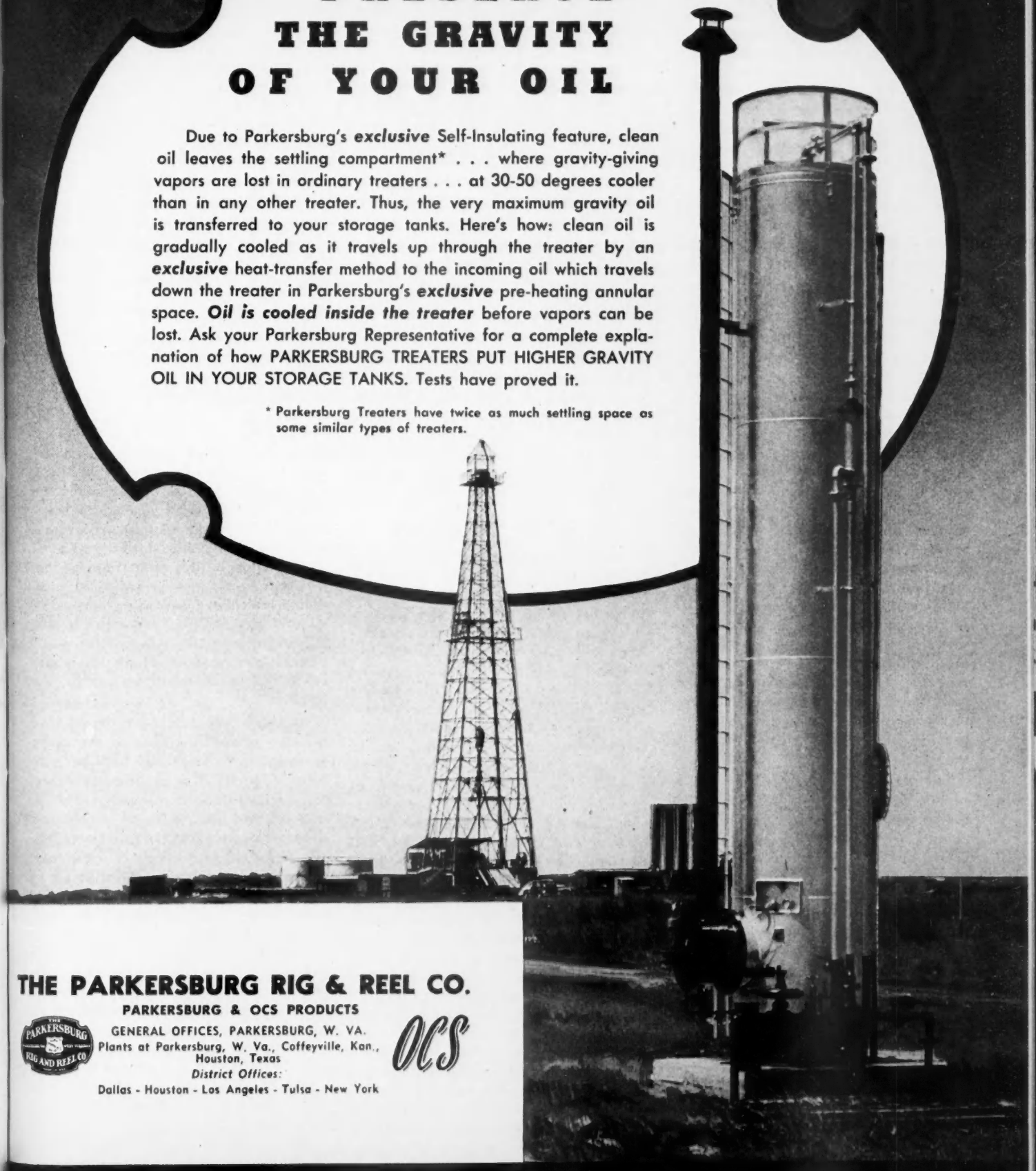

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the probable economics of the operation.

Other factors encountered in the development or proposed development of a secondary recovery operation may be, and often are, of almost equal importance to the economics of the operation as the factors just described. The condition of the primary producing equipment, both surface and subsurface, often is of major importance, particularly on deeper operations. In many secondary recovery operations, particularly in shallow areas, it has been common practice to plug and abandon all old producing wells and redrill the property to the desired pattern and extent. In many instances, particularly on extremely old properties, many of the producing wells had been long abandoned—and those, if any, still producing were in such condition that it was more economical to plug and redrill for secondary recovery. In deeper areas, and particularly younger properties, many, if not all, wells drilled for primary recovery can be used for secondary recovery. Thus, the condition of wells drilled for primary recovery and the extent to which they can be used in secondary recovery materially affect the development cost of the secondary recovery operation and the economics of the operation. Likewise, the condition of all surface equipment employed for primary recovery and the extent to which it can be used for secondary recovery affect the economics of the secondary recovery operation. In view of the cost for complete redrilling and replacement of all surface equipment, it is obvious that considerable development cost can be eliminated when maximum use of wells and surface equipment employed in the primary operation is possible. In fact, this factor alone may make the difference between a profitable and non-profitable secondary operation.

The availability of an adequate supply of injection fluid at a reasonable cost is important to any secondary recovery operation. Whether the injection fluid is gas or air for repressuring or water for water-flooding, the cost of furnishing either fluid at the desired volumes and pressures has an appreciable effect on the economics of the secondary recovery operation. In many areas gas is scarce and extremely valuable, and its costs may make its use prohibitive. Large volumes of compressed air are used in many repressuring operations to supplement the gas supply; and, although compression costs for either gas or air may be high, particularly for high injection pressures, such costs usually are not prohibitive. Thus, costs for furnishing the necessary air-gas mixtures for repressuring are not usually excessive.

Water for water-flooding also is scarce in many areas, and an adequate continuous supply often is more uncertain than supplies of gas or air-gas mixtures. Large-scale water-flooding operations require large volumes of water, and usually a shortage of injection water seriously affects the rate of oil recovery and the economics of the operation. The cost of furnishing suitable injection water varies considerably, depending upon the source of the water and the injection pressure. It is not necessary to consider these costs in detail here. Where sufficient volumes of water are available, either from surface or subsurface sources, the total cost of furnishing injection water usually is not great. In areas where water of any kind in large volumes is scarce, costs could be prohibitive.

Fuel and power costs in the area naturally affect the economics of secondary recovery operations. In this respect, a closely related factor for water flooding is the method of lifting the oil. In some operations flowing all of the oil production eliminates the cost of pumping equipment and high fuel or power costs, and greatly affects the economics of the operation. In other operations a conversion from pumping to flowing may materially affect the economics of the operation, and may result in prolonging the economic life of the operation.

Effects of Location and Size

The location and size of the secondary recovery operation also often affect the economics of the operation. There are many factors inherent to the location of the property which affect development and operating costs. Availability and cost of labor and oil field services often depend on location. Oil pipe line outlets or other means of oil transportation often have an influence on the price received for oil at the well head. In some areas, water disposal becomes an expense in water flooding. The size of the operation alone may have considerable effect. Usually a large operation can be developed and operated for lower unit costs than a small operation. The shape of the area, as well as the size, often affects development costs and, to some extent, the operating costs. A square area usually is more adaptable to efficient secondary recovery operations and less expensive to develop than a long narrow area or an irregularly shaped area. Existing primary lease terms and obligations to non-operating interests often are important in secondary recovery operations. Obviously, if high royalty interests are not reduced or non-operating interests do not participate in the cost of the operation, the profit is materially reduced. If unitization is impossible under the terms of the leases, or for other reasons, the profit from the operation may also be reduced materially; because not only are appreciable savings in development and operating costs possible under unitization, but also a more efficient secondary recovery is in many cases possible. Many other factors peculiar to individual operations or operators could be cited that have definite and important effects on particular operations. The factors that have been presented briefly not only control the economics of secondary recovery operations in general, but also offer a sound basis for determining the profitability of proposed operations. A thorough analysis of these factors, individually and collectively, not only determines the merit of secondary recovery in general for an area or a proposed operation, it also permits a determination of the type of secondary recovery operation that is the most feasible economically and the extent to which any secondary recovery operation is justified.

Secondary recovery of oil today is based upon sound engineering and proved practices. It usually is possible to determine approximately how much oil is left in a given reservoir and approximately how much can be recovered by repressuring or water flooding to a given degree or intensity. Having this information, secondary recovery is largely a problem of economics, i.e., balancing the total cost of recovery against the estimated value of the oil to be recovered. When the estimated value of the oil to be recovered per acre is small, repressuring with gas or air may be indicated, even though calculated secondary recoveries by this method usually are much less. When the estimated value of the oil to be recovered per acre is high, the higher costs for water-flooding usually are justified.

Although the detailed economics of the two general methods of secondary recovery differ and will not be considered herein, it is of general interest to point out that often the choice of the method, and the extent to which it is used, seriously affect the profit possibilities of secondary recovery. For example, in many areas repressuring with air or gas has been applied to reservoirs that could have produced more than sufficient oil by water-flooding to justify the additional cost. As a result of such repressuring, the recoverable oil by subsequent water-flooding often is insufficient to justify the cost. Thus, the overall economics of secondary recovery from the reservoir is seriously influenced. On the other hand, thorough economic analyses of all factors involved may show that the net profit per barrel of oil recovered by repressuring, or the total profit, is greater than that by water-flooding, even though the total recovery is much less.

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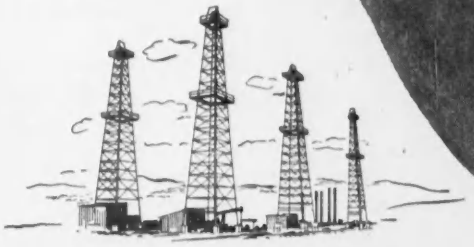

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secondary recovery often is controlled by other economic considerations of the individual operator. Here again industry-wide economic conditions, or the particular financial condition of the individual operator, may decide which secondary recovery method is employed. Depending on such factors for individual operations or operators, it may be more desirable economically to recover the maximum oil with a minimum profit per barrel in the shortest possible time than it is to recover a lesser volume of oil with a greater profit per barrel over a longer period of time. The time element itself often is an important economic factor in secondary recovery, particularly in considering the method to be employed. Water-flooding usually requires larger capital investments, and the recovery of oil must be sufficiently rapid and large to justify these investments. Repressuring ordinarily requires much less investment of new money, and a slower and smaller recovery is justified.

Both methods, however, are susceptible to the same balancing of costs against anticipated value returned. Wider well spacing and higher injection volumes and pressures often may greatly reduce development costs without serious reduction in recovery or rate of recovery. Likewise, many of the factors that affect development costs, and also many of those influencing operating costs, may, by careful consideration, be brought into desirable balance with the anticipated value to be returned. There are limits, however, to the extent that secondary recovery costs can be controlled, particularly in water-flooding. There are limits to the volume and pressure that be be used per injection well, as well as to the physical or economic limits on many of the operations in secondary recovery methods. Knowledge of such limits controls the extent to which secondary recovery costs can be reduced if the operation is to be successful physically. Therefore, to make a reliable estimate of the economics of secondary recovery for a proposed operation is quite complicated, and requires extensive knowledge and experience pertaining to secondary recovery operations. Engineering knowledge, in respect to secondary recovery, is extensive from both the theoretical standpoint and that of experience. The literature on secondary recovery is voluminous, with one national trade journal being devoted exclusively to this subject. Secondary recovery costs, however, are not so well documented. Costs for individual operations have been published from time to time; but, because of different accounting procedures of different operators and the great variation in conditions in different areas, only a general treatment of this phase of the economics of secondady recovery is justified.

Cost of Secondary Recovery

The total costs of secondary recovery operations, as already pointed out, may include many items with wide variations in magnitude of individual items between individual properties and operators. For the purpose of a general consideration, these costs may be divided into two general classifications. In the first classification are all costs pertaining to the development of a project. In the second classification are all costs pertaining to the operation of the project.

Under development costs, all investment costs and other cost items that may be charged as capital investment usually are considered against the oil to be recovered by the secondary recovery operation. Many operators have different methods of accounting, and between operators certain items may or may not be considered capital costs. No generally accepted practice has been followed. Regardless of methods of accounting, development costs should include not only all costs or investments for the installation of all equipment and facilities necessary to the application of the secondary recovery method employed, but also all costs or investments made in the acquisition of the property. Obviously, if the property is purchased, the purchase price is a capital cost. As already pointed out, the purchase price may reflect a complete economic study of the secondary recovery possibilities of the property, or it may reflect only salvage value.

In the first case, a reliable estimate of the recoverable oil and the total costs of recovery may be available to the purchaser. In the second case, it usually is necessary to make a rather extensive investigation of the secondary recovery possibilities of the property. This normally requires the time of experienced personnel to analyze all factors affecting the proposed operation, a certain amount of coring, and even pilot operation, before the possibilities of the property are determined. If the property is not purchased, the same type and amount of investigation and preliminary operations are necessary before such possibilities are determined. All costs in connection with such preliminary investigation, study, and tests—whether paid as a part of a purchase price or directly—represent the cost of the oil reserve to be developed and produced by secondary recovery operations. In a sense, these costs represent a finding cost for the secondary oil production. Theoretically, if complete information was available from the primary operations on the property, there would be little cost necessary in determining secondary recovery possibilties. However, the information available on most old properties is so meager and unreliable that to acquire the necessary information often involves considerable cost. Such costs, however on the basis of a per-acre or per-barrel of secondary oil reserves are not high. A few core wells may evaluate many hundreds of acres, and one pilot operation may prove the feasibility of secondary recovery for a large area. Such costs vary, and are subject to many qualifications or adjustments. It is estimated that these costs will average from a few dollars, or less, per acre to as much as $100 or more per acre when extensive coring and other testing is required. On a "per-barrel of secondary oil reserve" basis this average cost probably seldom exceeds a few cents per barrel. Although not large, these costs are necessary and important to determine the magnitude of the secondary oil reserve and its economic value.

The value of the reserve thus determined may be great or it may be negative from an economic viewpoint. In areas such as Bradford, the cost of evaluating a property is a small part of the value of the property. In other areas the cost of evaluation may exceed the secondary recovery value of the property. Thus, it may be seen that the secondary recovery value of a property may vary from some minus value, represented by the cost of the appraisal, to values even in excess of the profit normally anticipated from the operation. These are extreme values. There are few, if any other areas such as the Bradford field where values of undeveloped acreage may reach thousands of dollars per acre. There are many areas where properties have no value for secondary recovery. In many other areas, however, the value of secondary recovery property is appreciable. In general, in these areas, because of the risks and high development costs, no extremely high values representing a large part of the profit to be made from the operation are justified. Values in these areas, it is estimated, will vary from one to a few hundred dollars per acre, depending upon many factors from the value of salvage to a complete analysis of all factors.

The direct development costs for secondary recovery normally represent by far the major portion of the total costs of such operations. These costs usually are considered capital costs; and they include the drilling of wells, installation of injection systems, and all additional equipment or facilities required for the successful operation of the methods employed. These costs vary with depth, type of operation, and many other factors, as already discussed. When no new wells are necessary and high-pressure gas or air can be purchased, gas or air repressuring may be done at extremely

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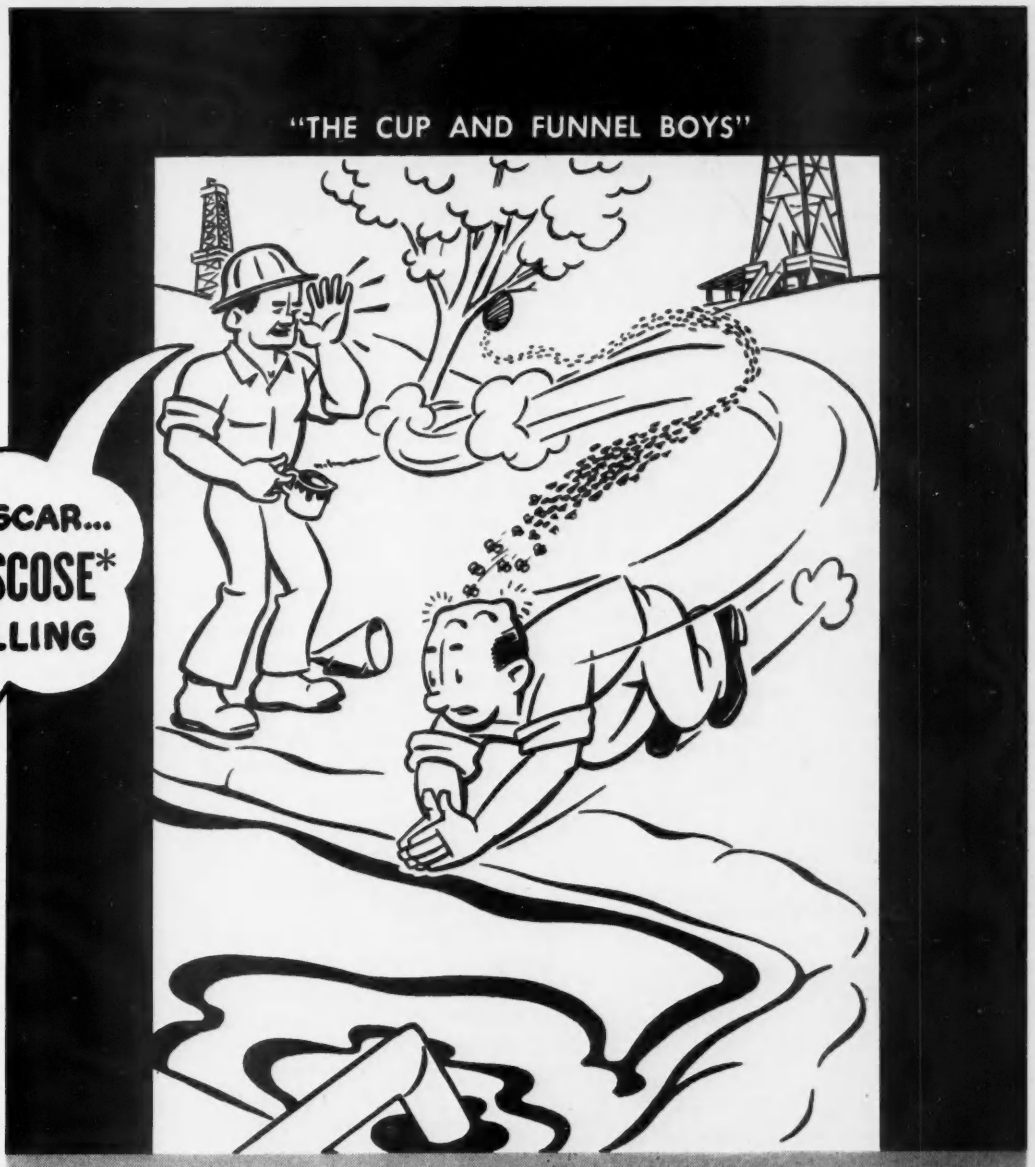

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low development cost. In these cases, however, the cost of the high-pressure gas or air becomes an additional operating cost. Water-flooding development costs normally are higher than similar costs for air or gas repressuring, and often in closely spaced operations extremely high per-acre costs are common. It has been estimated that development costs, depending upon the many factors involved, will vary from approximately $100 per acre to more than $3000 per acre; on a per-barrel-of-oil-recovered basis, this variation may amount to from a few cents per barrel to as much as $1 or more per barrel.

The operating costs involved in secondary recovery operations are not greatly different than those encountered in primary recovery operations. They involve the handling of oil, the operation of the injection system, and administrative overhead and taxes. Although these costs vary in different areas and for the type of secondary recovery method, the variation is not great. The major part of operating costs is for labor and supplies, so that costs for these two items usually control total operating costs. In comparison to primary recovery operations, secondary recovery operations normally require some additional labor and supplies; therefore, total operating costs for a given recovery by secondary methods usually are higher than those by primary methods. It is almost impossible to determine reliable unit average secondary recovery operating costs that would be of value. In individual operations, it is possible to estimate the costs for labor and supplies based upon similar costs for primary operations and, thus, obtain a satisfactory estimate of the operating costs for the particular operation and the particular operator. Operating costs are paid out of current production and, to a considerable extent, are controlled by the amount of current production. Therefore, in a consideration of the economics of secondary recovery, they have less importance than development costs, even though operating costs are often higher on a per-barrel basis. On a per-barrel basis, secondary recovery operations usually require more engineering supervision and special services than primary recovery operations. Such costs also tend to make total operating costs higher for secondary recovery operations.

Oil produced by secondary recovery is the same as the oil that was produced from a property by primary recovery. Many properties have produced more oil by secondary methods than by primary methods. Secondary recovery engineering and operating practices have developed so that, in many respects, they surpass similar development for primary recovery. There is no reason why many millions, and even billions of barrels of oil cannot be recovered by these methods. The economic feasibility of such operations has been proved over and over again in many areas for many years; on this basis alone, secondary recovery operations are more certain than proposed primary recovery operations. It usually is possible by sufficient investigation, study and testing to determine what the approximate net profit from secondary recovery operations on an individual property may be. The feasibility of the operation, then, is largely a matter for the individual operator to decide. In general, the operator in one way or another must balance the estimated profit to be made against the capital investment required and the risk involved. If this balance is satisfactory to the operator, the operation is feasible economically to that operator.

A complete engineering and economic study of a prospect will, to a large extent, determine the probable degree of success of the operation or the risk involved. With complete engineering and economic information available, it is estimated that the risk factor for the average secondary recovery operation is only in the order of 20 percent; i.e., there should not be more than about one failure out of five when sufficient and reliable engineering and cost data are available. Normally, the risk factor should govern the rate of profit anticipated on the capital invested; i.e., if the success of the operation is questionable and a high risk of capital is indicated, higher profits should be necessary to offset the higher risk factor. The profit or rate of return on capital invested, commensurate with a given risk, in secondary recovery operations is perhaps beyond the scope of a discussion of the economics of secondary recovery. Some operators may be satisfied with a low rate of return or profit for a given risk, whereas other operators for the same risk may require a higher rate of return or profit. Thus, the economic feasibility of the operation depends largely upon the individual operator, and the numerous factors individuals may consider in this respect. The cost of capital, the payout time, the economic life of the operation, and many other factors are important. Each factor may, and usually does, affect each operator differently in determining the economic feasibility of an operation.

Summary and Conclusions

The economics of secondary recovery of oil is controlled, to a large extent, by economic conditions prevalent in the primary recovery of oil. Costs of finding, developing, and producing oil by primary methods over a long term control the extent to which secondary recovery methods can be, and are employed, in the production of oil. When such costs are high, as they are currently, and the price of oil also is high, the economics of secondary recovery, in general, is more favorable.

The success of individual secondary recovery operations can be, and is, affected by numerous and various factors. The principal factors, however, are the volume of oil to be recovered, the depth to the producing formation, and the price and demand for the oil. Other factors may become extremely important. As examples, in certain areas the cost of acquiring the prospective acreage can be prohibitive; the cost of furnishing gas, air, or water for injection may be excessive; or the condition of the primary recovery equipment may seriously affect the economics of the proposed operation. All factors affecting the economics of an individual operation are subject to reliable engineering and economic analysis.

Total costs for individual secondary recovery operations vary widely. Because of the many factors involved, average costs are of little or no value. Normally, the most important cost is the development cost. This cost should include any cost pertaining to the acquisition of the property and/or the determination of its secondary recovery possibilities. Costs for acquisition or evaluation, ordinarily, are not high. Costs for actual development of intensive secondary recovery operations, however, are high, and are subject to limited control if the operation is to be successful physically as well as economically.

Operating costs, although higher than similar costs for primary recovery, do not vary widely, and economically they are less important because they are not capital investments like development costs. Successful secondary recovery operations have required experienced personnel, as well as specialized engineering supervision and technical services, to a greater extent than most primary-recovery operations. For this reason, operating overhead for secondary recovery has been usually higher than for primary recovery. In spite of these higher development and operating costs, secondary recovery operations have proved extremely porfitable in many areas, and large volumes of oil have been recovered which otherwise might have been abandoned.

Economically, secondary recovery operations are feasible in many areas. It is largely a matter of engineering and economic investigation to determine the risk and profit involved. In comparison to exploratory drilling as a means of increasing crude reserves, secondary recovery methods currently offer many advantages economically, and probably will continue to have these advantages in the future as the costs of discovering new reserves increase.

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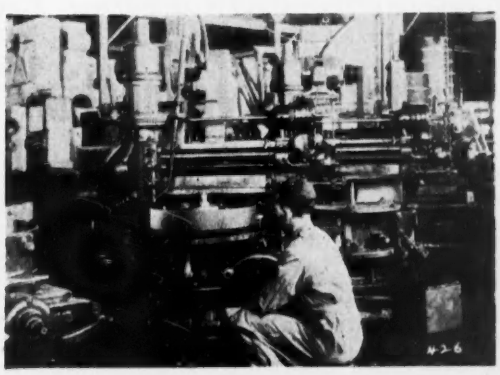

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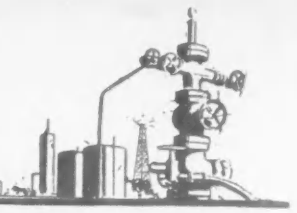

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How To— Construct Easily Replaceable Hardwood Rod Line Guides

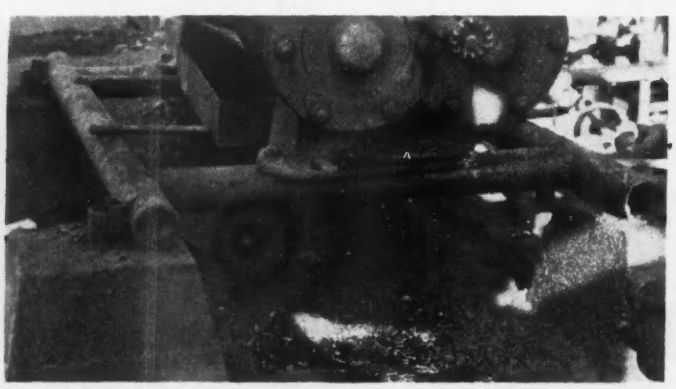
Various methods and devices are utilized by stripper well operators for providing efficient and long-lasting guides for jack plant rod lines. Usually incorporated in the system is a hardwood block through which a hole is bored for passage of the rod, when such a block becomes worn, it usually must be discarded or shifted to a new position for boring of a new hole. Doing away with the time usually spent in such repair jobs is the type of installation shown.

A short piece of eight-inch casing set vertically in concrete and cut out on opposite sides is fitted with two half-round segments of ordinary wood. These serve as fillers and between which may be dropped a bundle of three hardwood boards, the latter having their sides slightly rounded, although it is not essential, in order to better fit the curvature of the pipe. The bundle is equipped with a light handle for use in pulling the bundle from the pipe. The center of the three boards actually is two short pieces, spaced to provide room for slight vertical movement of the line but because of the two flanking pieces, all but slight sideways movement is prevented.

When the hole becomes worn, the bundle is pulled out and the two center pieces re-spaced, and if necessary, the two outer ones shifted or reversed to bring the rod into contact with unworn portions of the guide. The two outermost fillers need not be changed inasmuch as the rod does not contact them. Only a saw and hammer and nails are needed to make all necessary adjustments on a worn guide.

How To— Set Emergency Pump with Skid on Oversized Foundation

When several pumps of similar manufacture, size and foundation pattern are used, an emergency pump can be rigged up to replace any one of them without pouring concrete or taking time out to build a temporary setting. The emergency pump need not be of the same type as the permanent installation, and is bolted securely to a grid frame of extra heavy pipe with longitudinal members cut and fitted to lay on the concrete piers.



In this pump setting, four piers are employed with nipples placed to fit into the base of the permanent pump. The emergency pump grid foundation has saddles of split pipe welded to the lengthwise members to fit the nipples in the piers, holding the setting solidly in place and preventing movement in any direction. The pump is then bolted to the two cross braces.

Of additional interest is the oil drip pan seen just underneath the pump and supported on the pipe framework. This drip pan is fabricated from sheet metal and covers the entire area under the pump where oil may leak. The pan is supported by two sections of sucker rod material which span the longitudinal pipe skid. These rods are welded into the pan and held securely in place. Any oil leaking by the packing glands on the fluid end of the pump is collected in the pan.

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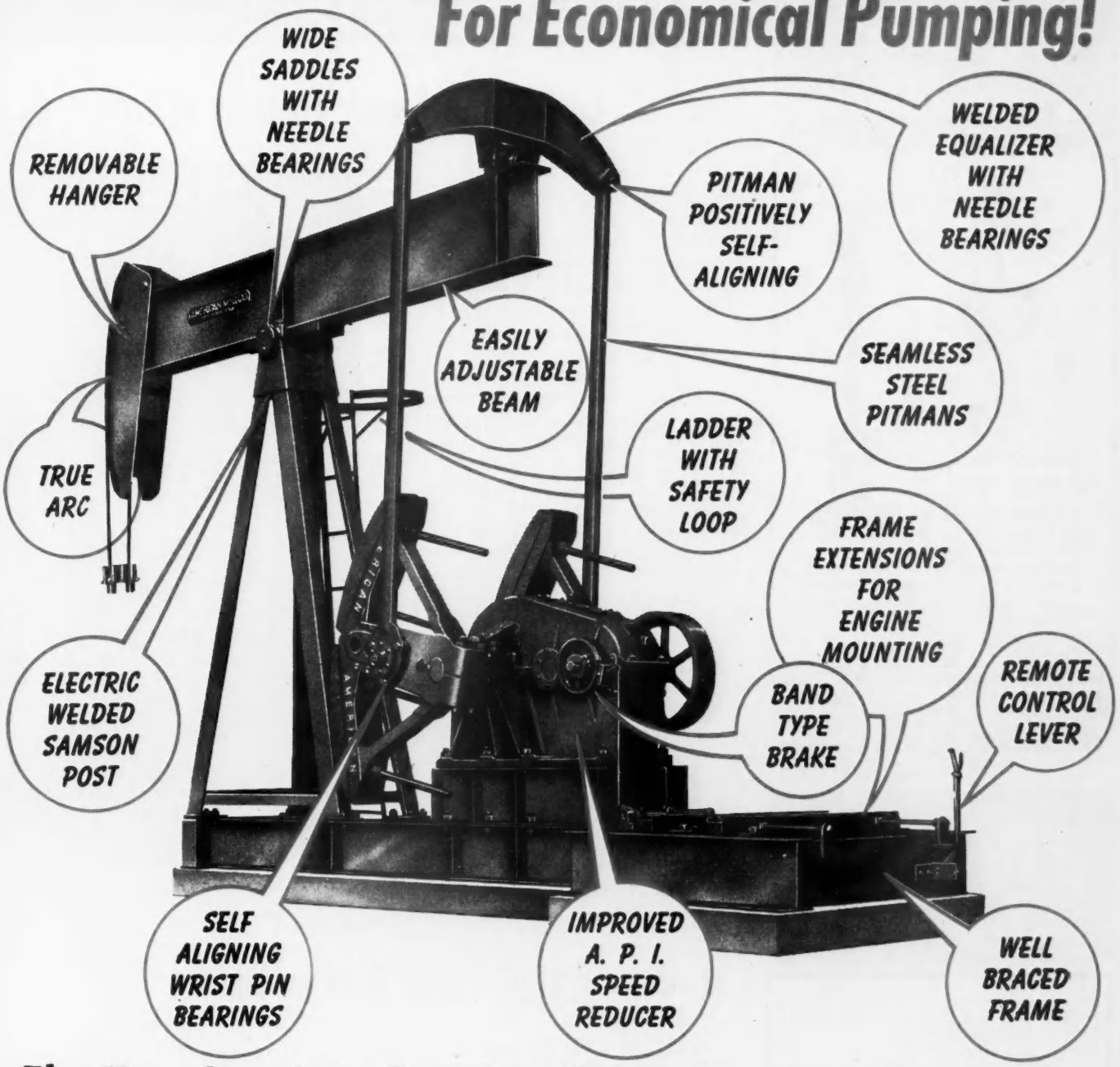

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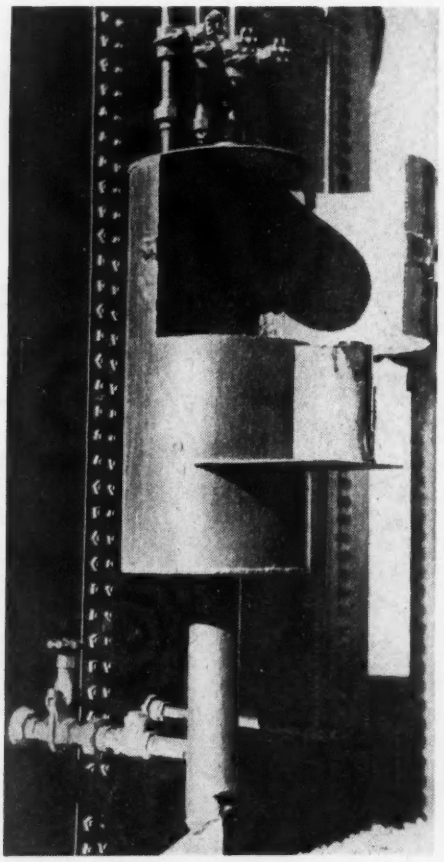
How To— Conveniently Sample Contents of Tank



Lease tanks are commonly set in pairs so that one is being filled with oil while the other is being pumped to the pipe line after the gauger has released the contents. Sampling of the oil for bottom, middle and top is also commonly done with sample lines connected to the shell of the tank at the required levels. These lines converge at a common point, entering a cylinder made of light weight 12-inch pipe about 30 inches long with flat heads welded in both ends. The top head has three nipples to which the three samples lines are connected with lip unions, and the lower head is fitted with a three-inch nipple resting on an angle iron support.

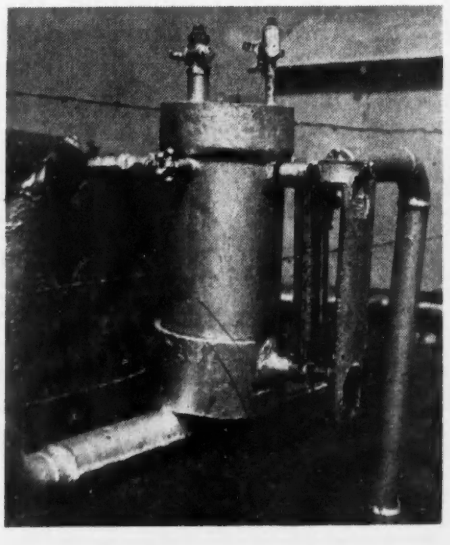
In the side of the cylinder at the top end is a hinged door made by cutting a section with a torch so that it will open and close easily and exactly fit the opening. Midway between the lower part of the door and the base is placed a semi-circular plate welded to the side of the cylinder as a platform upon which sample cans can be placed while withdrawing the oil for testing. Spills from the sample lines fall into the lower part of the cylinder and are disposed of when the tank has been pumped out by opening a gate valve in a one-inch line connecting the lower end of the three-inch supporting nipple and the tank.

How To— Protect Gauge Glass on Odorant Tank

To provide a ready means for determining the amount of odorant in a container floated on a station gas supply line, a section of a surveyor's rod was fastened behind the gauge glass. The plainly marked graduations on this scale were easily read, and the fluid level checked against them. To protect the gauge glass and scale from dirt and mud spattered from the nearby highway, a shield of scrap pipe was cut out and hung over the upper gauge cock.

The shield was a piece of 2½-inch pipe, split lengthwise, with a cap at the top to fit over the cock. This cap was cut out or notched to fit behind the stuffing box nut, and thus to remain in place.

A second cut out section at the base allowed the shield to hang across the lower gauge cock stem, where the extended sides prevented it from swinging in the wind. The shield could be lifted off to observe the liquid level, or to permit occasional wiping down of the glass to remove dust accumulations.



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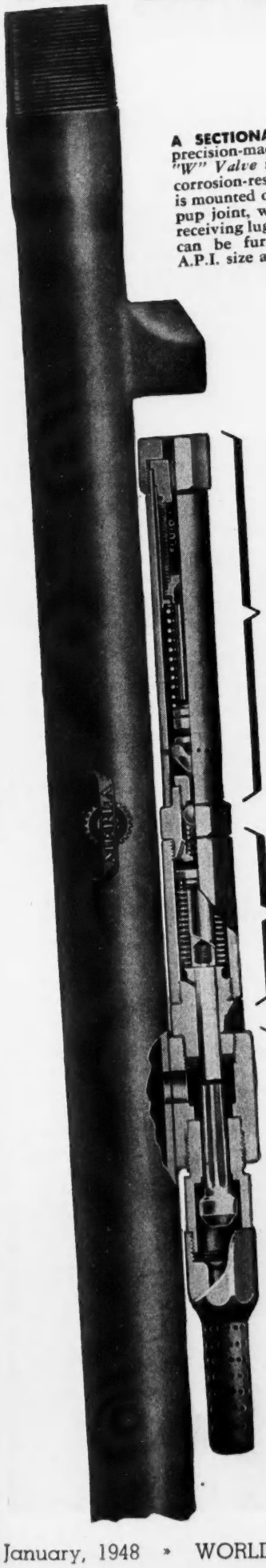

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3. Main Valve Assembly *consists of the inlet valve thimble, inlet valve and inlet strainer cap. It is especially designed to minimize cutting action by gas and sand. The valve stem is triangular in shape; the head has top and bottom seats to give a back check action when reverse fluid flow is encountered. Operation details are fully described in Merla Tool Corp. bulletins. Write for them.*

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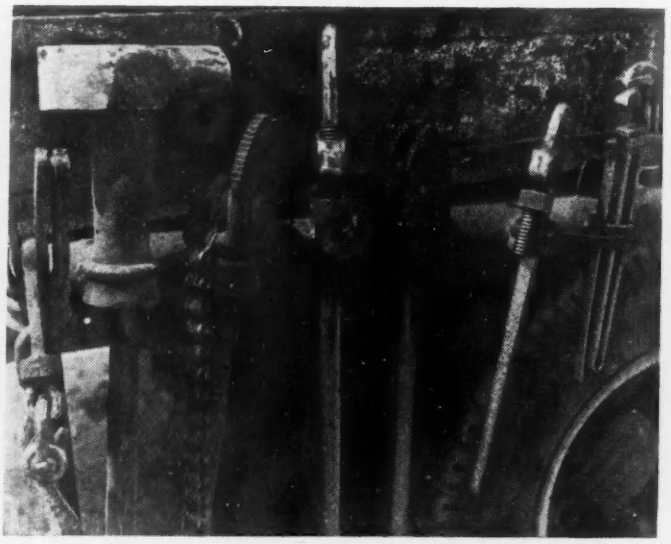
How To— Add Handy Tool Rack to Pulling Unit



Open and readily accessible racks for carrying hand tools are practical when the pulling unit or truck is stored at night in a garage or enclosed yard. On one such unit the production crew devised a means of carrying tools that not only speeds their location when needed, but provides a rough check on whether all tools have been accounted for when the truck leaves a particular job.

Along one side of the truck bed was welded a series of tubing thread protectors into which can be inserted practically all tools that might be used on the average pulling job, including load binders, sledge, tongs and wrenches of several sizes. Carried in this position, the tools are readily available, eliminating the usual searching through tool boxes with attendant lost time when a particular tool is urgently needed. Any size rings, or any number of them may be attached to the sides of the truck bed.

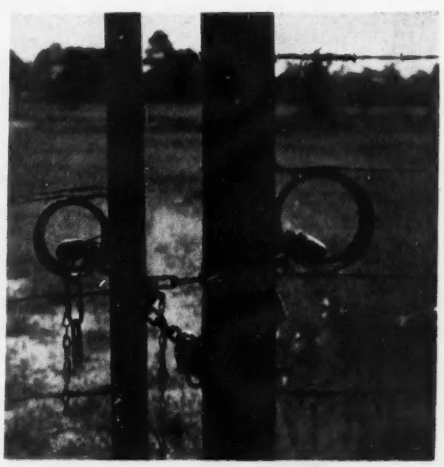
How To— Prevent Entry Through "Community" Gate

A pipe line tank farm was built on a plot of ground which had been checkerboarded and leased to several producers. This joint ownership made it necessary for gaugers, switchers and lease gangs from several companies to have free access to the area. At the same time, because of gas and fire hazard, trespassers and unauthorized persons were kept out as much as possible.

The gates on the roads entering the tank farm were locked by an ingenious method. Each company furnished one of its standard padlocks, and these were all connected together with short bits of chain. Any company employee had only to open the lock for which he had a key in order to gain entrance.

To make it easy to slide the chain-padlock arrangement around to get at the proper lock, pipe collars were welded to gate and fence post and the chain passed through them. This kept the arrangement from dragging on the barbed wire, and saved the workers from snagged hands and gloves.

In case the gate was left open, it was easy for the pipe line engineer to trace the culprit, as the unlocked padlock indicated the company whose key had opened it.



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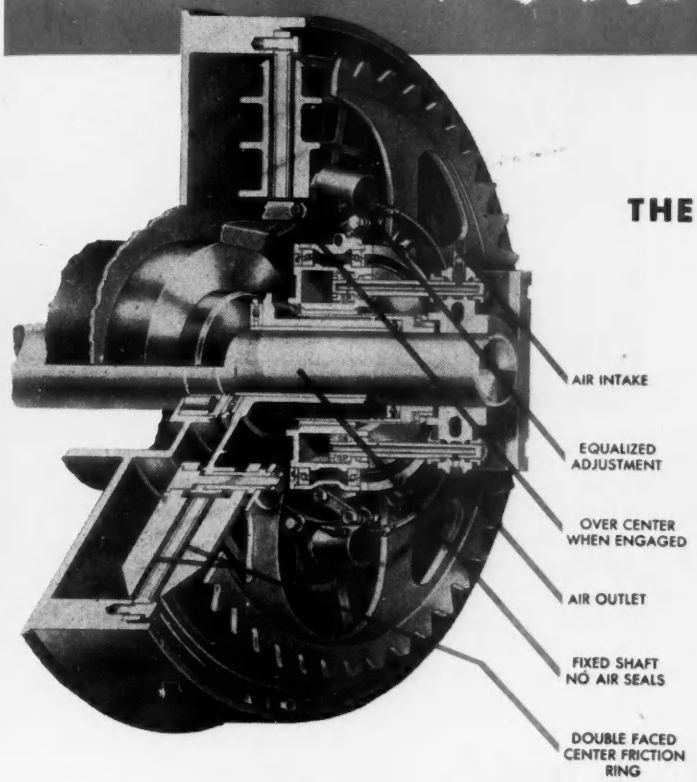

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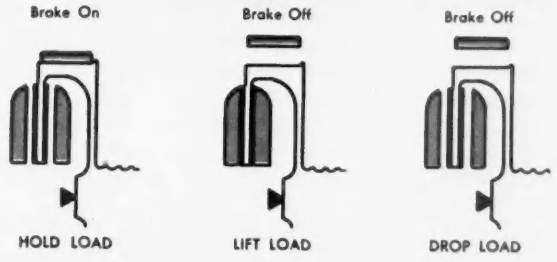

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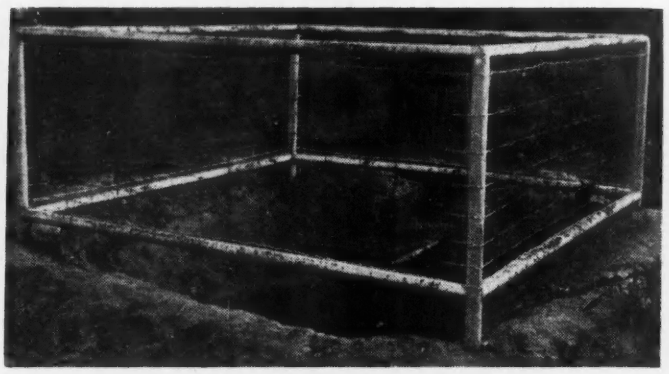
How To— Build Cattle Guard at Blowdown Pit



Most leases in one field are used by their owners as grazing ground for their stock. For this reason, it is not permitted to blow down the separators in the usual manner. If this were allowed, the cattle would lick the ground around the blowdown pipe, and might be poisoned by the impurities carried with the salt.

One producer dug a small pit for the blow line, and put up a fence which encloses the pond of fluid when it was drawn off. The liquid evaporated rapidly. Only a deposit of salts remained, and it was safely shut in behind the fence.

The four corner posts were driven into the ground before the cross pieces were welded in place. This anchored the fence so cattle could not force it aside to get at the salt.

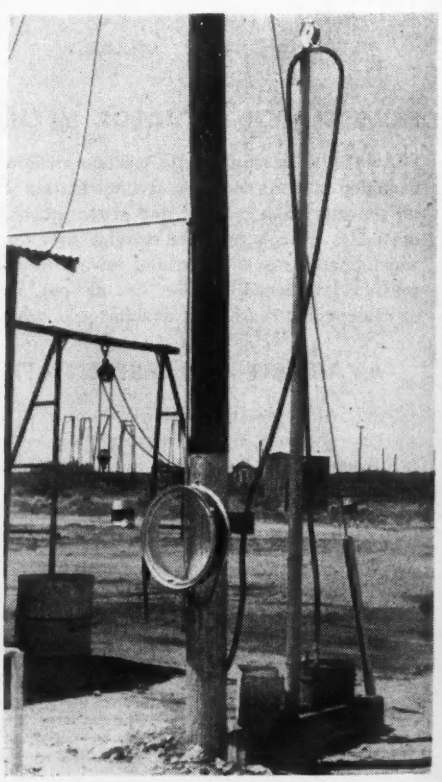
The pit was placed far enough from the separator so the blow would not carry fire to the separator in case of a grass fire or a spark caused by the blow in the gravel of the pit.

How To— Rig Up Truck Servicing Equipment

An inexpensive device which helps to reduce time spent in servicing trucks, pulling units and similar motorized equipment is employed by the maintenance division of one company. The water hose situated near the gasoline pump is equipped with a pole and counterweight system that keeps the hose off the ground, yet always makes it available for servicing any part of the equipment provided the vehicle is spotted reasonably close to the pole.

Some 12 to 15 feet high, the pole consists of a length of light pipe set in concrete and atop which is a sheave mounted on the edge of the pipe as shown. A light line attached to the approximate center of the hose passes over the sheave and down inside the pipe to a counterweight, the latter being free to move up and down the pipe. When not in use, the hose is automatically drawn up in the position illustrated where it is out of the way of possibly being crushed or injured by vehicles. It is particularly valuable for filling radiators of engines located in the more difficultly accessible pulling unit engines.

To minimize danger of freezing during winter weather, the water line is brought up above ground level through a small drum filled with sawdust. The air hose situated nearby is stored by wrapping on a salvaged truck rim spiked to the side of an adjacent power pole.



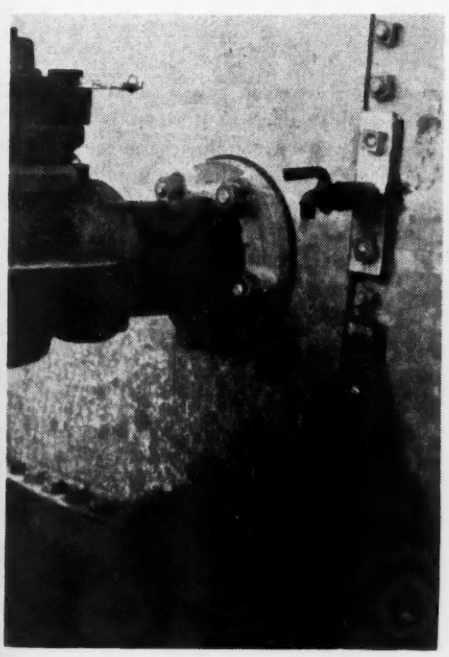
How To—

Install Sample Valves On Lease Stock Tanks

To provide a quick method for determining whether the water "bottom" in a tank is high enough to contaminate the oil when it is run out, one producer equips each tank of his field batteries with a pair of sampling cocks. One of these is set so as to sample the tank contents two inches below the outlet, the other two inches above the top of the outlet nipple.

As the tank metal is not thick enough to stand tapping for the threads on the sampling cocks, a short piece of ½x2-inch strap iron is used, being cut long enough to span three of the bolt holes in the vertical lap joint of the tank. Holes are drilled through these strap irons, to coincide with center distances of the tank bolt holes. The upper and lower holes are drilled to fit tank bolts, while the center one is tapped to pipe thread size to take the tapered, threaded end of the cock. This center hole, aligning with the bolt hole behind it, allows oil to flow from the tank when the valve is opened.

Samples from the lower cock give warning of the build-up of water within the tank and permit it to be drained off before it can reach the outlet. The upper cock gives a sample which closely approximates the oil flowing into the outlet line at the time of sampling.



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PRODUCTION HINTS

How To—

Prevent Entry of Air Into Suction Lines

Lease tanks that flow into a line having considerable slope to the gathering system pump, or which gravity direct into the pipe-line farm tank, sometimes flow dry before the switcher can complete his rounds, and thereby permitting air to enter the flow line. This air, rising to a high spot in the line, can cause it to become air-bound, cutting off flow until the line has been tapped and purged.

An automatic check has been devised and used by some companies which "remembers" when the switcher forgets. The unit consists of a special nipple, cut into the flow line just below the tee on the end of the horizontal run from the tank. This nipple has a seat, approximately an inch less in diameter than pipe size welded into it.

A five-foot riser, capped and provided with a bleed cock at the top, is screwed into the upper opening of the tee. Inside the riser, and just slightly smaller in diameter than the pipe, is a wooden ball (some use a hollow Neoprene ball) which floats on the column of liquid within the riser until the tank level drops enough to let the ball seat on the nipple, thus closing the suction line before air can enter.

A tripping lever, operated by the handle shown projecting from the nipple, lifts the ball from its seat if it does not float free when fluid is again taken from the tank. Air is admitted to the riser by means of the quarter-inch petcock at the top, thereby providing an air cushion which checks surging of the flow and pounding of the ball on its seat.

PIPELINE MANIFOLD *REBUILT* WHILE IN FULL OPERATION

The tank farm and terminal at Webster, site of the new manifold. The farm contains 63 tanks, and through it passes a monthly total of 7,000,000 barrels of oil. The new manifold lies just to the left of the pump house in the right foreground, being built on the site of the outmoded manifold constructed 30 years ago. Outstanding feature of the construction was the building of the new manifold over and around the older units without restricting the passage of oil at any time.

By GORDON B. NICHOLSON

REPLACING an outgrown pipe line manifold with a modern, highly-engineered, and streamlined manifold located on the identical site without interfering with movement of oil was an engineering feat recently accomplished by Humble Pipe Line Company. The new installation offers convenience and flexibility of operations which heretofore were only a pipe liner's dream. It is located at a major point for movement of tremendous volumes of crude piped through lines which converge at the company tank farm and station terminal for final delivery to refineries.

Webster, Texas, is the site of Humble's tank farm. Its location 21 miles southeast of Houston marks the junction of several important arteries which bring crude from scores of oil fields throughout the Southwest. Large volumes of the oil reaching the terminal are directed to Humble Oil & Refining Company's refinery at Baytown, with some crude also routed to refineries in Texas City and vicinity.

The original pipe line terminal and manifold were built about 30 years ago, long before pipe line engineering reached its present stage and in the days when Humble was but a beginner in the oil business. Its design was calculated to handle adequately normal production increases, but not the tremendous gains made by Humble in the following years. With increasing volumes, and with oils of many diverse characteristics reaching the Webster station, operational problems multiplied until facilities at the station became seriously inadequate.

Much time and thought were spent designing the proposed manifold to replace the original manifold with its capacity of about 8 million barrels monthly. Objective was to excavate and remove the old manifold, increase its maximum capacity, install a more flexible system for handling crudes of various grades without contamination, and erect a completely new manifold on the site of the old one while simultaneously handling the full capacity of oil. That this objective was accomplished in its entirety and without loss of a single barrel of oil is a tribute to the design, engineering, and workmanship behind the project.

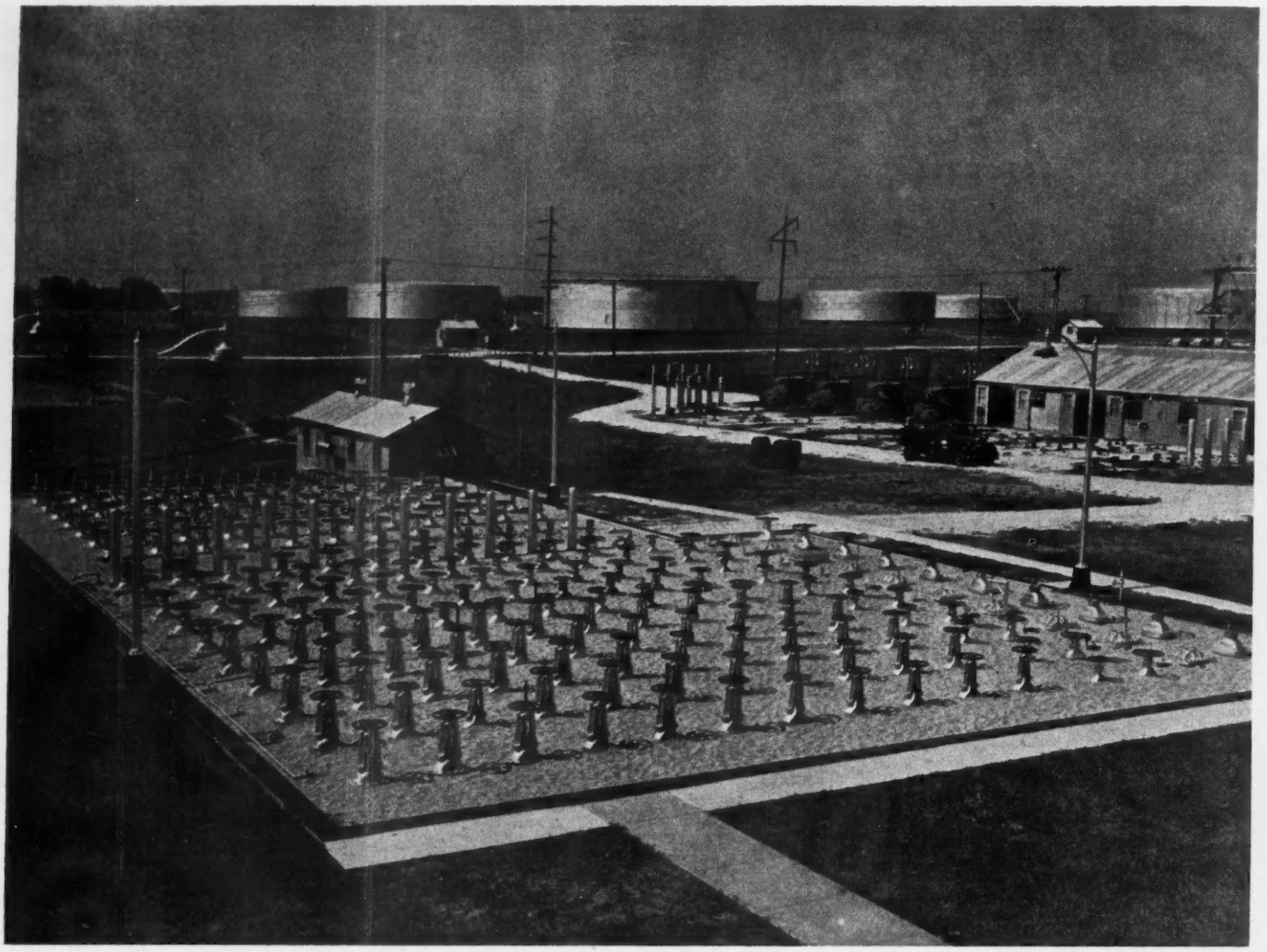
Plans for Cellar

Plans called for extending the new manifold site as a continuation of the old manifold; the entire old portion to be converted to a single large suction system, and the extension to accommodate the discharge. The initial work on the project included digging a cellar for the proposed discharge, with a uniform depth of three feet for the combined sections. Gentle sloping of the terrain required that in addition to digging to reach cellar depth, on the west end fill was necessary in order to elevate the cellar floor to a common level.

First excavating began late in December, 1945, with Humble Pipe Line Company furnishing crews for this and all subsequent phases of the job. Difficulties immediately became apparent through the appearance of many uncharted lines which formed barriers to the excavating. These lines, some buried almost 30 years and of different sizes, were also found at odd and varying depths and sometimes sloping. With the proposed new manifold encompassing a larger surface area than the old one, all pipes in the way of the new cellar were traced to points well away from the manifold area, removed, and replaced by temporary lines which bypassed the new cellar location.

As excavating progressed, winter rains soon turned the black land into a sticky quagmire which challenged the resources of the workers. Pipes uncovered were removed by winch trucks, but the soil was so slippery that often, as the winches reeled in the lines, the trucks themselves were pulled back into the excavations when the pipes refused to budge. Ditches filled with water almost as soon as dug.

In February, excavation on the cellar was completed, and concrete was poured for the floor. Steel-reinforced, the slab was ten inches thick, designed to support the 84 gate valves and the connecting pipes which comprise the discharge. Setting of the concrete was followed by erecting valves and lines of the discharge. Four sections of 21 valves each constitute the discharge, with the all-welded units of each section brought in by winch trucks for mounting. All valves were erected with stems vertical, requiring more space than an angular setting, but providing ease in manipulating on



The new station manifold at Webster presents a pleasing spectacle consisting of an orderly arrangement of valve stems and wheels protruding upward through the gravel fill of the cellar. Sidewalks, landscaping, paint, and floodlights enhance the appearance of the manifold, while the multiplicity of valves and underground piping insures flexibility in handling oil of different gravity and bound for different destinations. Oil bound for the large Baytown refinery and refineries in Texas City pass through the manifold, which marks the convergence of several major pipe line arteries bringing oil from many fields of the Southwest.

completion of the manifold. All pipe sections were leveled with care through specially designed cradle jacks by which minute adjustments were made.

Completion of the new discharge was followed by a tedious and time-consuming laying of some 18,000 feet of eight-inch lines to replace the old discharge lines and tie into the main lines going to Baytown and Texas City. Old lines were dug up, requiring another period of excavating with the same hindrances of wet weather, mud, and uncharted lines that faced the workers in the earlier digging.

During all the months consumed by the work up to this point, the original manifold was in full use and continued to handle the entire volume of oil in the same manner as for 30 years past. Now, after completion of the new discharge and after laying all new discharge lines, the new discharge was placed in operation, with the old suction continuing to function. Next on the schedule was removal of the now-idle 30-year-old discharge.

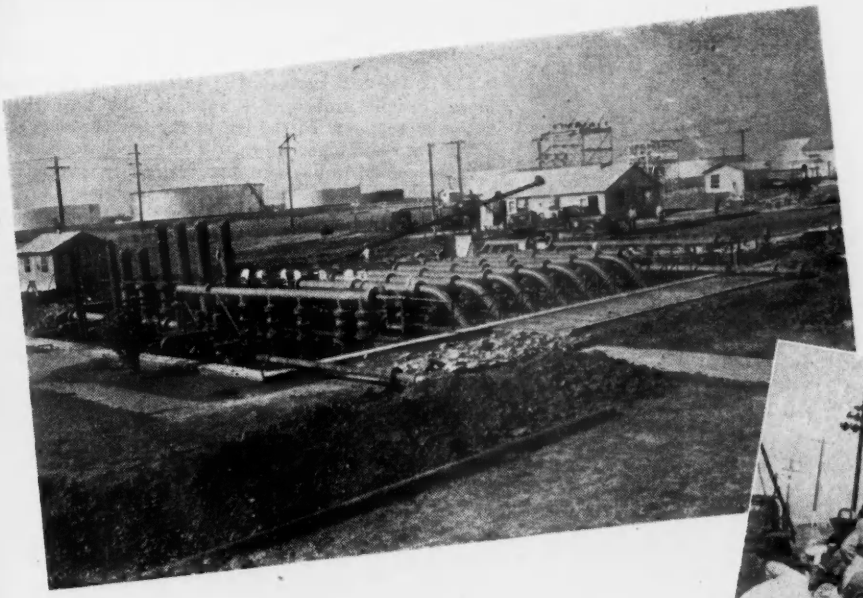
Equipped with improvised booms extending over the cellar area to permit lifting the old valves from position, winch trucks played a prominent role in removing the old discharge. Upon removal of the entire discharge, the area cleared furnished a site for the first portion of the new suction, which soon was built in a manner similar to erection of the new discharge. After completion, this part of the suction was placed in operation, and assumed the entire load of the old suction which until now had carried the load.

Next step entailed dismantling the old suction. Principal problem encountered in this phase of the project was removal of the heavy portions located near the center of the cellar, requiring lifting units up and over the just-completed new suction. This difficulty was handled by attaching a 70-foot boom to the rear of a winch truck for lifting and removing portions of the old suction.

With the first section of the new suction handling all oil passing through the manifold, the old suction was removed and rebuilt, and upon completion was also placed in operation.

Additional long, tedious, and at times disappointing effort still remained before final completion of the project. This work included refinements such as constructing cellar walls and sidewalls, filling the cellar with sand topped with chat as a fire prevention measure, painting, and installation of floodlights. These activities were time-consuming, but did not interfere with the actual performance of the manifold. Not until August, 1947, was the project considered complete in entirety, marking the end of 20 months of activity. The manifold now presents the ultimate in safety, operational efficiency, and attractiveness in design, with the intricate underground project consisting of 216 gate valves being designated on the surface by only a simple and orderly arrangement of valve stems and wheels. Appropriate markings indicate sources of supply for the suctions, and proper disposition of flow from the discharges.

See picture story on following pages.

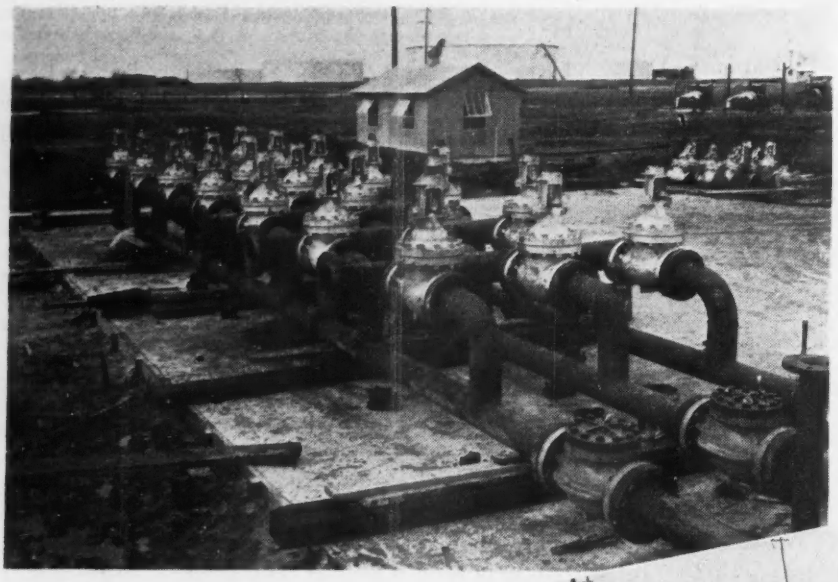


LEFT: Photograph taken from same approximate location as the picture of the completed manifold shows the old manifold shortly after excavating began. Nearest to the camera is the discharge, while just beyond it is the suction. Most of the excavating occurred at the extreme left of the picture, where the cellar was extended to provide space for the new discharge. After completion of the new discharge, it was placed in operation and the old discharge dismantled. On this spot, part of the new suction was built. Then, with it in operation, the old suction was dismantled and the remaining part of the new suction built. During the entire process, the suction and discharge systems were operative, and movement of oil through the manifold was unimpeded.

RIGHT: First step in constructing the new manifold consisted of enlarging the area where the original manifold was located, and digging a cellar of level and uniform depth. Excavating was complicated by unearthing uncharted lines, buried 30 years previously, at different depths and sometimes sloping. All old lines occupying the new cellar site were removed after new lines were laid for replacement.

LEFT: In mid-February, concrete for the extended cellar floor was poured. The slab, designed to support the new discharge section, is ten inches thick and steel reinforced. The task of constructing the new discharge was then started. Comprised of 84 gate valves, eight-inch lines lead into the discharge from the pumphouse, while ten-inch lines leave the discharge with oil directed to Baytown or Texas City refineries.

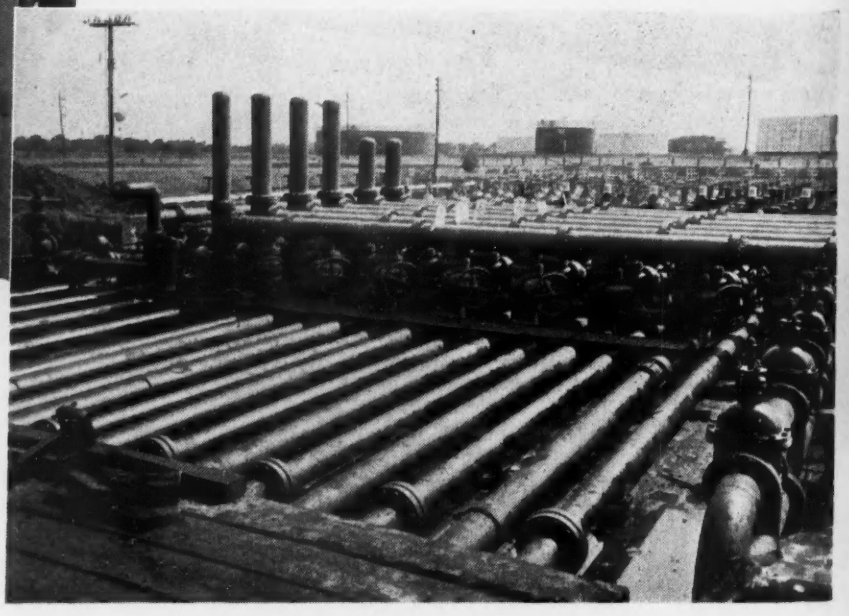
RIGHT: The all-welded units of each discharge section were bolted into place, and carefully leveled. Adjustable cradles facilitated leveling, each cradle containing four corner bolts for raising or lowering as desired. These cradles, sometimes elevated by supporting steel blocks and resting on steel plates, provide permanent supports for the pipes and were left in position when the cellar was filled on completion.



LEFT: The first section of 21 valves in the discharge was completed before bringing in the next three similar sections. To the left of the row of valves are the open-end pipes which will later feed connecting lines leading to Baytown and Texas City. During the time the discharge was under construction, the old manifold, located out of sight in the right foreground, continued to operate at full capacity.

RIGHT: Progressing at a fast rate with erection of the discharge, this photograph taken from approximately the same location as the one above, shows all four sections totaling 84 valves in position, occupying the entire new portion of the cellar. Before the new discharge could be placed in operation, however, lines connecting the discharge with the main lines leading to refineries had to be constructed.

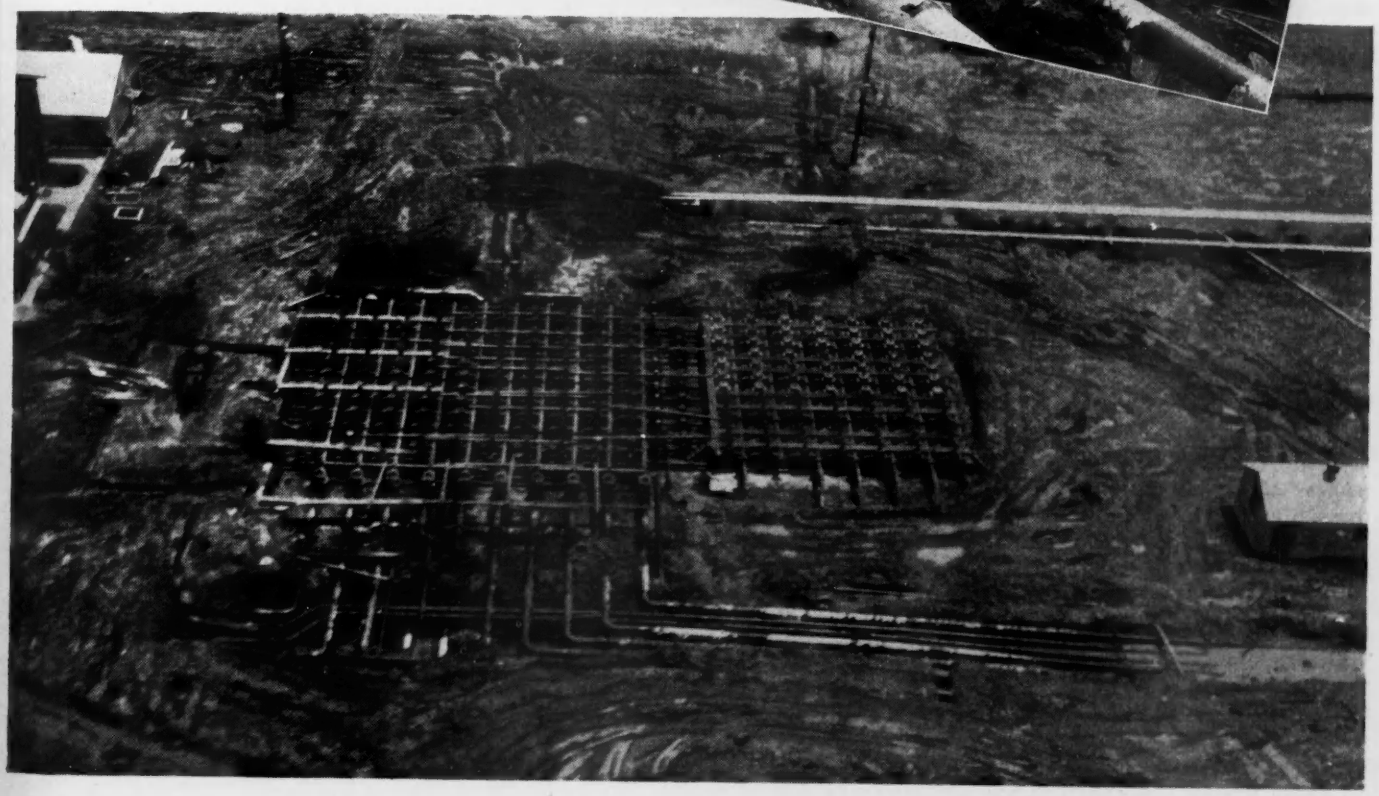
LEFT: Photograph of valves on the old suction shows oblique-horizontal arrangement which required less space but were difficult to manipulate. Contrast with the vertical arrangement of valves in the above photograph, with valve wheels in horizontal position and easily accessible. Also note that the old cellar was open, whereas the new cellar contains a sand fill to reduce fire hazard.



RIGHT: With the new discharge operating, the now-idle old discharge was removed, formerly occupying the space in the foreground. Alternate lines appearing here are connected to the suction, the others continuing to the discharge, visible in the background. At this stage of construction, the old suction has not been affected, and continues to handle the full load. First part of the new suction will be built on the site of the old discharge.

LEFT: Upon completion, the new portion of the suction was placed in operation, and the old one disconnected and removed. With the new suction carrying the entire load, the second and final part of the suction was then erected. Location of this project was near the center of the manifold, and all parts were lifted out and over the new suction by means of a winch truck equipped with a 70-foot boom. In this photograph, the entire new suction has been completed, and the new discharge appears in the distant background.

RIGHT: Nearing the end of the construction, all lines leading to the suction were replaced. Design of the old manifold had necessitated use of "crossovers" as an insufficient number of lines entered the suction. This complicated switching oils of different grades without contamination. The new suction is fed directly by 10 lines and eliminates crossovers.



—Aerial photograph courtesy of Airflite, Inc.

Aerial photograph shows entire manifold immediately after full capacity operations started. Left portion of the manifold is the new suction, fed by ten lines clearly seen leading into it. Oil moving through the suction passes through the pumps housed inside the pumphouse visible at the left of the photograph. The powerful pumps then move the fluid through the discharge which comprises the section of manifold seen at the right. Manipulation of valves on the discharge directs flow into lines leading to Baytown and Texas City refineries.

Gauging Methods In Atmospheric and Low-Pressure Storage

By C. C. KEANE
Chief Engineer, Great Lakes Pipe Line Company

WITH advancing technical application in all branches of the petroleum industry, tank-gauging methods have come in for a small share of the improvements. Nevertheless, the cumbersome and inefficient methods of the past, such as gauge poles and hand float devices, still exist in the same plants with the most modern electric gauging mechanisms.

GAUGING methods usually divide into three categories: pole or hand line, float-operated automatics for visible reading at the tank, and remote-reading units, either electric-powered or air-actuated mercury columns. Investment cost is lowest in the hand-operated units; but, as traveling manpower is needed to walk and climb tanks to accumulate gauge data, labor cost with its limited accomplishment quickly dissipates the investment saving over the more elaborate remote types.

In the float automatics, investment costs increase appreciably, but the labor to read them accomplishes 75 per cent more gauge readings in the allotted time. The increased labor productivity and the hazards associated with tank climbing combine to make the float automatics economically attractive and decidedly safe to operate.

Remote-Reading Equipment

In the remote-reading equipment, costs are greatest, and vary appreciably with the type of powered unit used. It is obvious that in large storage tanks the gauge pole is unwieldy and cannot be used; hence, if hand gauging is to be standard, the gauge line with plumb-bob end must be used. This is usually the accepted gauging technique when companies take custody of petroleum for transportation or purchase it for other use. Because gravity, temperature, water content, sampling, and water-and-sediment tests are interlocked with the gauging operation and all are generally taken from the top of the tank, it is not illogical that the gauge level be checked and listed at the same time. In fact, it is the simplest known method of checking levels and, if properly done, it is exceedingly accurate because of the absence of the usual coterie of automatic devices.

Although the remote gauging method may be just as accurate and satisfactory as the hand line, it offers little advantage in ownership transfer of product, because the other functions interlocked with volume and specification determination cannot be remotely transmitted by any existing methods.

In intra-company operations, where net volumes are computed on a 24-hour basis with gross volumes on an hourly schedule, the remote electric gauge offers many advantages. On tank farms, where several tanks may be in operation simultaneously, gauging by any other method results in a complex accumulation of over and short volumes, because the human element cannot be depended upon to read levels on the unit time increments set up as standard.

Hand Lines and Float Automatic

The mechanics of hand-line and float automatic gauges are too well-known to elaborate in the details of operation and design.

In remote-reading gauges, a myriad of ideas and arrangements has been presented to the industry, with a supporting clientele for practically every scheme.

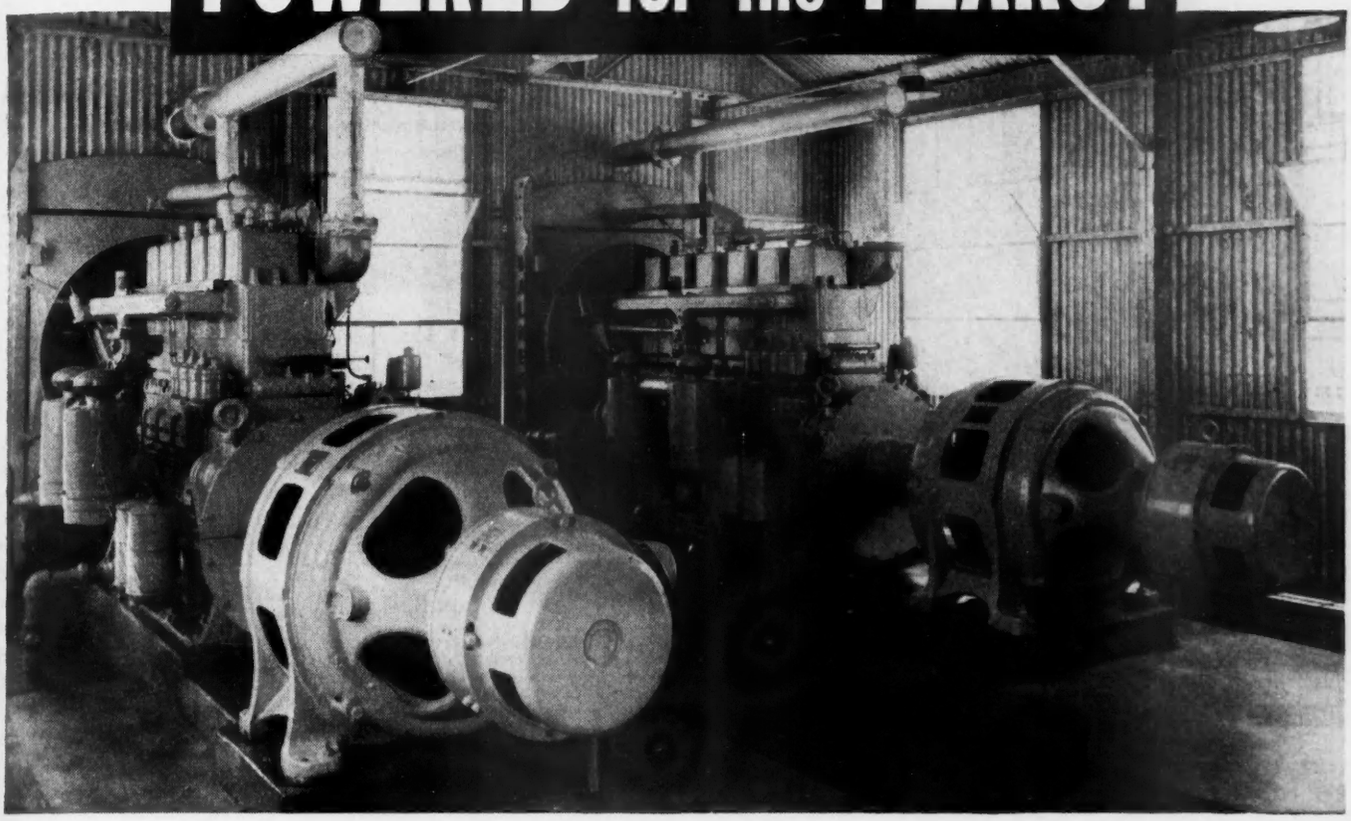
In listing a few of the more prominent units, we find the selsyn motor designed into two schemes, i.e., one using two individual transmitters and receivers for each tank, and another type with selector switch that permits as many tanks as there are points on the switch to be gauged in any desired order. One receiver for feet and inches is used in this arrangement. To prevent the transmitter from moving out of synchronization with the receivers, the inch-transmitting motor is coupled through a geneva motion to the foot-transmitting motor, and this motor is limited to one turn for the full liquid-level travel of the tank. The motor sending the feet position cannot shift out of phase even during extended power-outage periods, and the inch-control motor will always pull the other receiver into an angular position duplicating its own. As a rule, selsyn motors have very low torque characteristics; hence, it is essential that the receiving mechanism be delicately balanced and free from friction drag.

It is claimed by the manufacturers of these motors that phase relationship between transmitter and receiver can be maintained with a maximum angular displacement of one degree, which is 1/30 of an inch in level movement. Inasmuch as tank tables are usually computed in ⅛-inch increments, the claimed accuracy is well within the allowable tolerance. The stability of the equipment is sometimes upset by the breathing action of the selsyn motors, which permits moisture precipitated from the air to deposit on the windings. This eventually causes shorts or grounds. In the cascaded type, the magnetic contactor should be oil-immersed. In certain styles of selsyn installations the current is on all the time and, unless class 1 group "D" specification wiring and conduit

■ CONTINUED ON PAGE 174

Preprint, subject to correction, of paper for presentation to Division of Transportation Subcommittee on Products Pipe Line Technology, before the 27th annual meeting of the API, Palmer House, Chicago, Ill., November 10, 1947.

Lone Star Gas Co. generators... POWERED for the PEAKS!



You're in Tyler, Texas . . . in the engine room of the Lone Star Gas Company. The power units you see are a pair of gas burning 6-LROU Waukeshas, with vacuum compensated governors, driving 250 KVA Westinghouse Alternators with outboard exciters.

They're big units . . . these 6-LROU Waukeshas—six cylinders, 8½ in. x 8½ in., 2894 cu. in. displacement. Big . . . but smooth. Flexible, too. And speedily responsive. Ready with reserve power that can handle the peaks when they come.

Reliability is *built-in* . . . to suit the Waukesha 6-LROU for this kind of work. Or your kind of job. Individual interchangeable cylinder heads, mounting spark plugs and large steel-alloy valves. Hardened alloy exhaust valve seat inserts. Roller type valve lifters. Hardened wet sleeve type renewable cylinder liners. Interchangeable twin cylinder blocks. Each block contains three cylinders.

Heavy drop-forged, heat-treated steel crankshaft. Seven 4¼ inch main bearings with replaceable bushings.

Full pressure oiling by positive, gear type submerged pump. Rocker arm and push rod mechanism oiling controlled to provide intermittent pressure feed. Waste packed replaceable oil filters. For all the details on this power unit, get Bulletin 840.

There are other Waukesha Engines and Power Units for every oil field need. Horsepowers range from 10 to over 400 hp. Consult Waukesha engineers.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS., NEW YORK, TULSA, LOS ANGELES

WAUKESHA
OIL FIELD POWER

Factors Influencing Commingling In a Products Pipe Line

THIS paper presents a brief summary of the methods used to minimize and control commingling or intermixing of adjacent products during pipe line shipment.

By D. A. ROACH
Products Pipe Line Department, Phillips Petroleum Company

THE necessity of commingling control and the methods economically justified to secure this control will, of course, vary widely in different pipe line systems. Each system is a special problem due to differences in length, design, equipment and type of product handled.

The methods of commingling control described in this paper are used on Phillips Petroleum Company's products pipe line system from Borger, Texas, to Chicago. This system originally consisted of 946 miles of 8.07-inch inside diameter line. Twenty-one partial loops of 8.25-inch I.D. pipe totaling 355 miles have been added to date. Twenty-seven pump stations containing 113 centrifugal pumps driven by gas engines are in use. Deliveries are made to nine terminals, while products are received for shipment at five locations. Thirteen different products are regularly transported by this system.

Measures to minimize commingling or intermixing are observed on all product shipments. Three classes of products receive particular attention and are referred to as "special products." This group of products consists of (1), kerosine, burning oils and distillates; (2) butane; and (3) aviation gasolines.

The first step in commingling control of a special product consists of proper sampling and testing before the product is accepted for shipment. Attention is given to product specifications which are most susceptible to the effects of commingling or intermixing.

If sampling and testing indicate the tender of special product is acceptable, the dispatcher schedules the product for shipment. Attention is given to the products which will precede and follow a special product in order to minimize commingling. The sequence used is as follows:

Special Product	Preceding Product	Following Product
1. Kerosine, Burning Oil or Distillates.	25,000 barrels of refinery gasoline	3,000 barrels of refinery gasoline.
2. Butane	3,000 barrels of natural gasoline.	3,000 barrels of natural gasoline.
3. Aviation Gasoline.	1. 25,000 barrels refinery gasoline.	1. 500 barrels of alkylate adjacent to aviation gasoline.
	2. 500 barrels of of alkylate adjacent to aviation gasoline.	2. 25,000 barrels of refinery gasoline.

Commingling is minimized during handling from tankage to the pump suction of the initial station by use of separate suction lines, line draining and washing, blinding off connections where necessary, or a combination of these methods.

The special product is again sampled at the pump suction of the station initiating the shipment. These samples are taken at short intervals on the head of the slug and at 30-minute to one-hour intervals throughout the remainder of the slug. If the first samples and tests indicate that commingling is continuing after the leading portion of the slug has been received, an immediate attempt is made to determine and correct the cause.

Tests indicate that the length of the intermixed or commingled portion between successive slugs tends to increase, very little with continuing line travel. These tests also indicated that after the initial station, the length of the intermixed or commingled portion was proportional to the number of stations through which the products had been handled. The source of this increase in the volume of commingling during station handling is the "dead fluid" in station bypasses and equipment.

The "typical station layout" drawing shows the location of the major quantities of "dead fluid" in station piping or equipment for a typical station of this system. The majority of the stations on this system were built prior to 1937. The importance of eliminating sources of "dead fluid" in station designs was not given full consideration at this time. However, no changes have been made in these stations to eliminate this major source of commingling.

Instead of making piping and equipment changes, the leading portion of the slug of special product is used to displace or wash the "dead fluid" from station bypasses and equipment. Thus, the effect of commingling is principally contained in the leading portion of the slug. This procedure eliminates the possibility of this "dead fluid" being slowly displaced and absorbed by a considerable length of the slug of special product.

Specifically, the station operator takes the following steps to eliminate these sources of commingling prior to the arrival of a special product.

1. Bypasses, drains and pumps the contents of the sediment trap back into the line several hours before the special product arrives.

2. Places all pumps in operation at least 15 minutes before the arrival of the special product. If this is not possible, a portion of the stream is diverted through the idle pump.

3. Washes the station bypass by circulating the product through the two-inch scraper kickoff line. This washing is started approximately 15 minutes before the expected arrival of the special product and continued until a specification or pure special product is being circulated.

In addition to the procedures de-

* Paper presented before the ASME National Conference on Petroleum Mechanical Engineering at Houston, October 6, 1947.

What has made NATIONAL SEAMLESS *the First Choice?*

THE unprecedented depth to which oil wells are being drilled today has placed increasingly severe demands on drill pipe, casing, and tubing.

Seamless tubular goods have met these critical demands with phenomenal success.

That's why all drill pipe—practically all tubing and a very large proportion of casing are made by the seamless process.

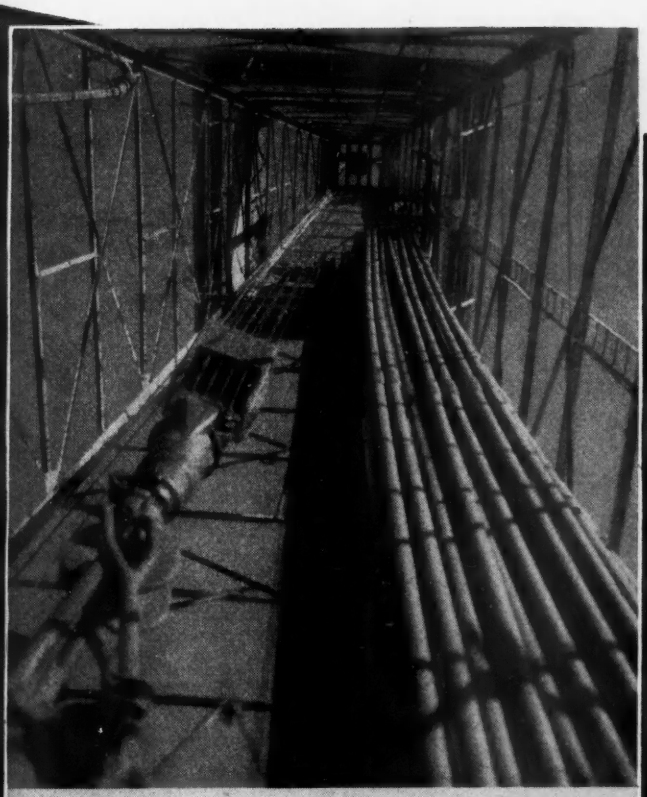
Pierced from a solid billet of steel, NATIONAL seamless tubular goods have no welds . . . no line of potential weakness. They are absolutely seamless from end to end. They have been improved both in steel composition and physical properties to meet new conditions. They have the same uniform wall strength and dependability throughout. You get quick, easy stabbing . . . smooth make-up and tight joints.

Records show that NATIONAL Seamless tubular products are first choice for more outstanding jobs than any other brand of oil country goods. For complete information write National Tube Company, Frick Building, Pittsburgh, Pa. for Bulletin No. 15 "Seamless Drill Pipe, Casing, and Tubing."

NATIONAL TUBE COMPANY

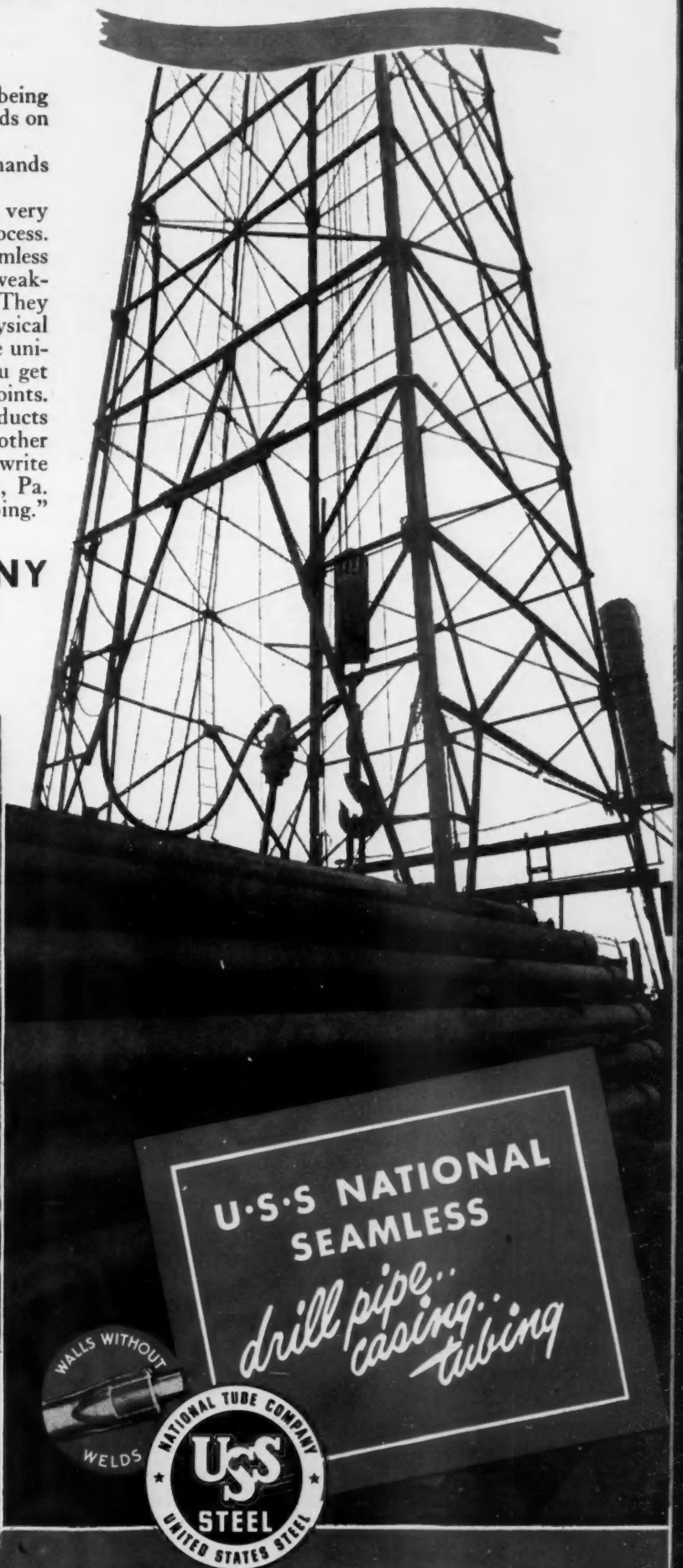
PITTSBURGH, PA.

United States Steel Export Company, New York

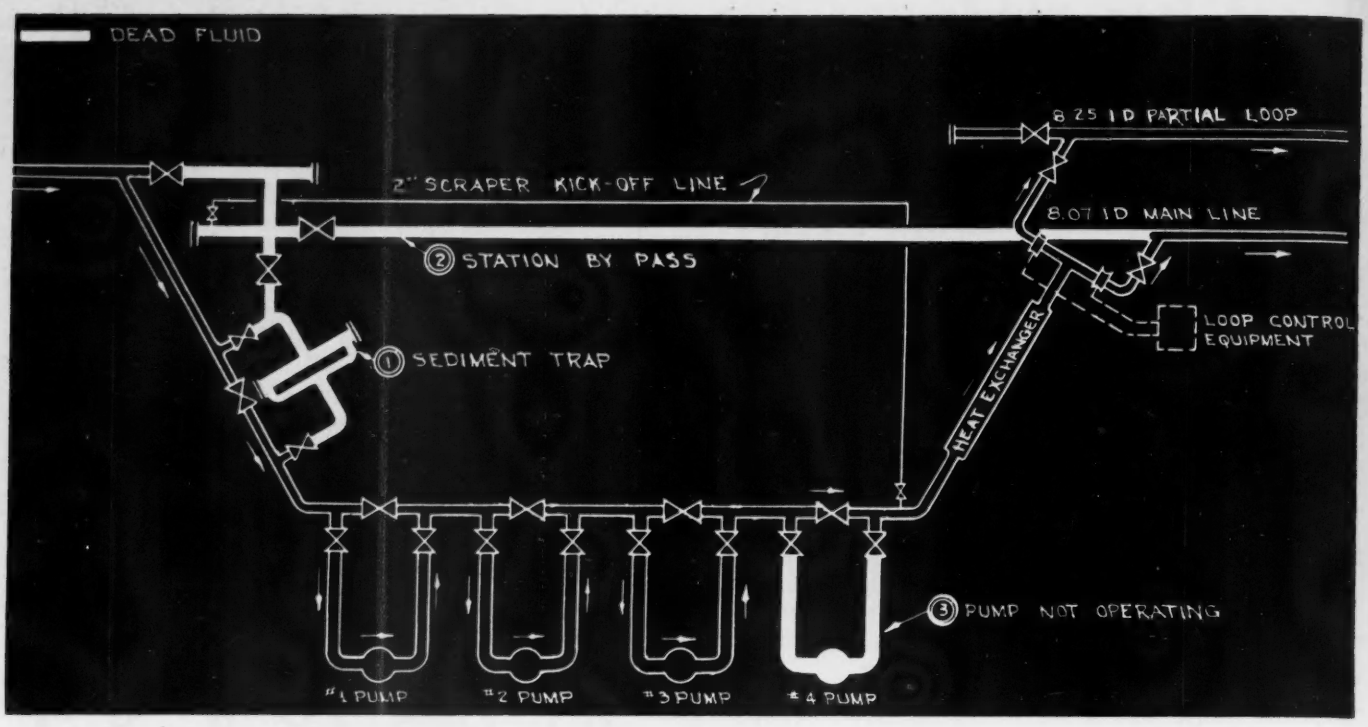


No welds—no possibility of any weak spots in this National Seamless Casing, pierced from a solid billet of high quality steel.

The threads of National Seamless are cut with a high degree of accuracy. This permits fast stabbing—fast running time.



UNITED STATES STEEL



Typical Station Layout.

scribed above, special care is taken to operate the partial loop and main line "in balance." This eliminates the possibility of additional commingling at the ends of the slug. This commingling would occur if different line velocities in the partial loop and main line section were permitted.

The success of these procedures for control of commingling is dependent entirely upon the technique and cooperation of the station operator. Detailed written instructions covering station operations during the handling of a "special product" are issued to each station. Samples also are taken at key points as a slug of special product moves up the line. Written reports covering tests of these samples are required. These reports make it possible to identify the location at which any operator might have been negligent.

The amount or quantity of commingling experienced in the operation of this system probably could be reduced by extensive system changes and additions. The procedures outlined above have been found effective, simple and economical in controlling and limiting commingling of successive products being transported in this system.

Gauging Methods

■ CONTINUED FROM PAGE 170

seals are used throughout, the danger of fire is ever present.

Inductance in long transmission lines affects the synchronization of selsyn sending and receiving motors and, if circuit design features do not compensate for this, serious inaccuracies occur.

Impulse relay gauges, sometimes called pulse motors, are built as individual units, and cannot be used in cascade. Each tank, through its individual transmitter is electrically coupled to its own receiver, and power is on all the time. If a power outage occurs and the tank level is changing while the gauge is inoperative, it is necessary to synchronize manually the receiver and transmitter when the power energy is again available. On a large tank farm, with ten or 12 active tanks all subject to simultaneous power outages, one can readily see how sizeable a rephasing of all such gauges would be. To do it properly, a telephone circuit should be available at each tank.

A third design of electric gauge, known as the step contact type, has given satisfactory performance in floating-roof, cone-roof, expansion- and pressure-storage systems. With low-voltage direct current for actuating its relays through step contacts, it cannot drop out of phase in periods of power interruptions. Using oil-immersed contacts with a float switch to open the power-feed circuit on loss of oil, it also incorporates in its design a magnetic coupling that transmits driving torque from the float mechanism to the contactor sender. Extension shafts, packing glands, and friction seals are not used. In pressure storage this type of gauge couple is quite advantageous, because the hazard of a packing-seal blowout is wholly eliminated.

One receiving panel serves as many as 48 tanks, and its circuit includes a telephone-jack arrangement that connects to every tank. Initial adjustments are easily made, and subsequent check tests may be quickly accomplished through the telephone circuit. In addition, gate switchers on the tank farm find the phone circuit useful when in need of instructions from the center of operations. Using a multiple-cable circuit, which is energized only when the actual gauging is being done, it is not difficult to project the possibility of using the circuit for transmitting temperature, gravity, water content, and water and sediment; in fact, everything except sampling.

The need for a gauge in the industry that will do more than accurately transmit levels is very real. Levels have to be converted to capacity in barrels which, in turn, must be multiplied by a factor to get net barrels in the proper group.

The ideal gauge would accurately determine net or gross barrels by direct reading, and would also indicate temperature, gravity, as well as water and sediment of the liquid volumes under scrutiny. The industry is ready for such a unit, and it remains for some enterprising manufacturer to come up with the solution.

Radar FOR RIVER OIL TOWS

The "Paul Blazer," now radar-equipped, moves up the Ohio with an eight-barge tow of crude.

RADAR, a war development which contributed in a large measure to the defeat of Japan and Germany, is being applied in peacetime on the inland waterway towboats serving the oil industry. Ashland Oil & Refining Company has equipped seven of its towboats operating on the Ohio-Mississippi river system with radar and thus becomes the first oil company using those waterways to have such a large proportion of its towboats so equipped.

Having proved the efficiency of radar in river navigation with its pioneering trials begun about a year ago, the company recently completed the installation of radar equipment aboard the last of its four larger towboats, the Ashland, at the company's marine repair terminal, Catlettsburg, Ky.

Nationwide attention was attracted to the trials conducted with Ashland's towboat, Tri-State, following the installation of a radar set late in 1946, and it was recently announced by M. C. Dupree, Ashland Oil's transportation manager, and Robert L. Gray, marine superintendent, that in the first nine months of 1947 the Tri-State operated 120½ hours in dense fog while all other nearby river traffic was stopped. Actually, the time saved amounted to considerably more than 120½ hours, for many of the other boats tied up for the fog were stopped in the fog area long after the Tri-State had moved into the clear.

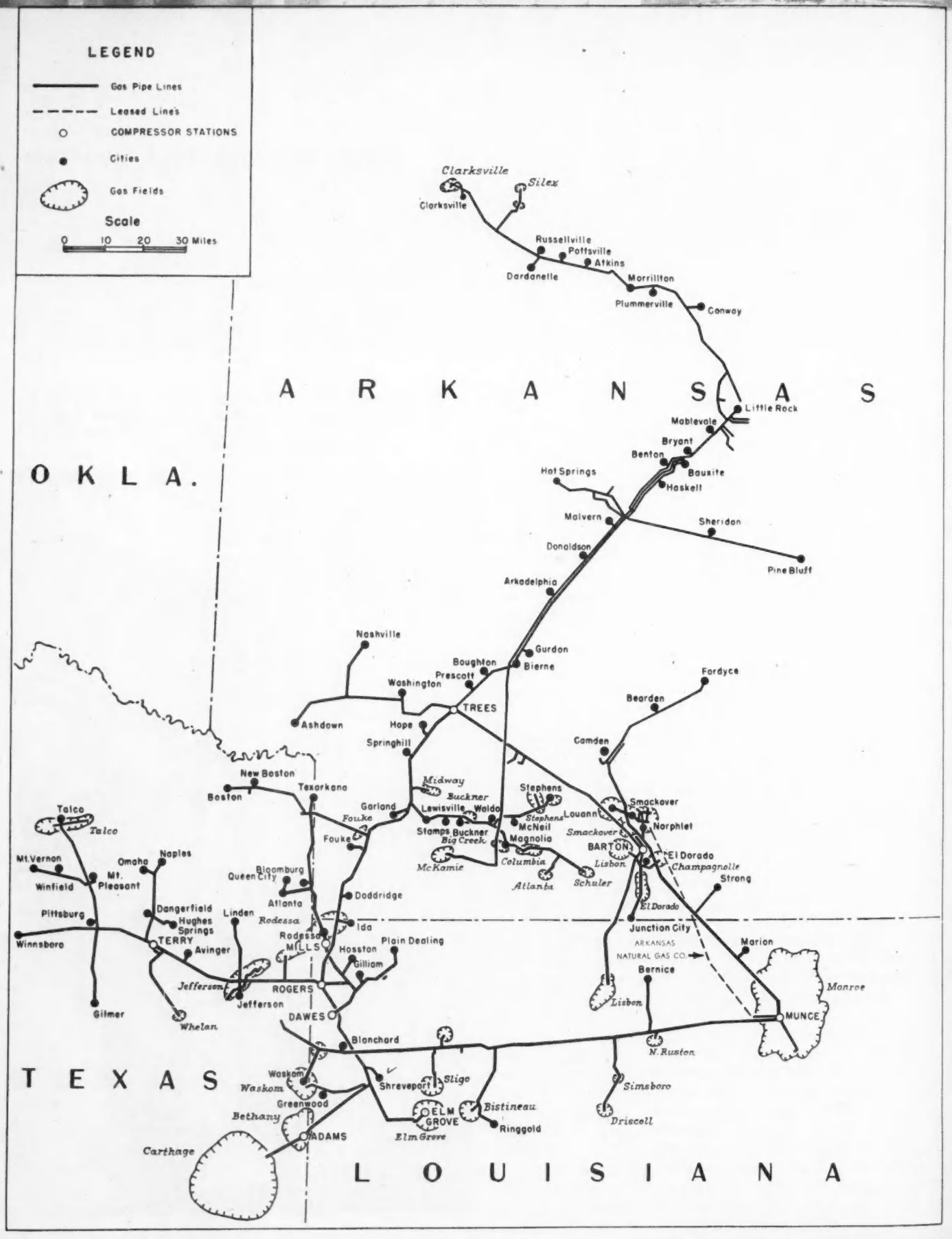
Such a time-saving was foreseen by Ashland Oil officials after the Tri-State had made a few trips with radar, and orders for equipment for the three other larger boats of the Ashland fleet were placed early in 1947.

Trials aboard the Tri-State developed a number of refinements in radar equipment for river use, and these have been incorporated in equipment aboard the Ashland. Similar equipment was installed on the towboat Jim Martin, and next to receive the navigation aid was the Paul Blazer. On its first eight-day round trip on the Ohio River between the Catlettsburg terminal and the crude oil loading terminal at Mt. Vernon, Ind., the Jim Martin saved 10½ hours of running time. On a subsequent trip it saved 7½ hours of time in two days.

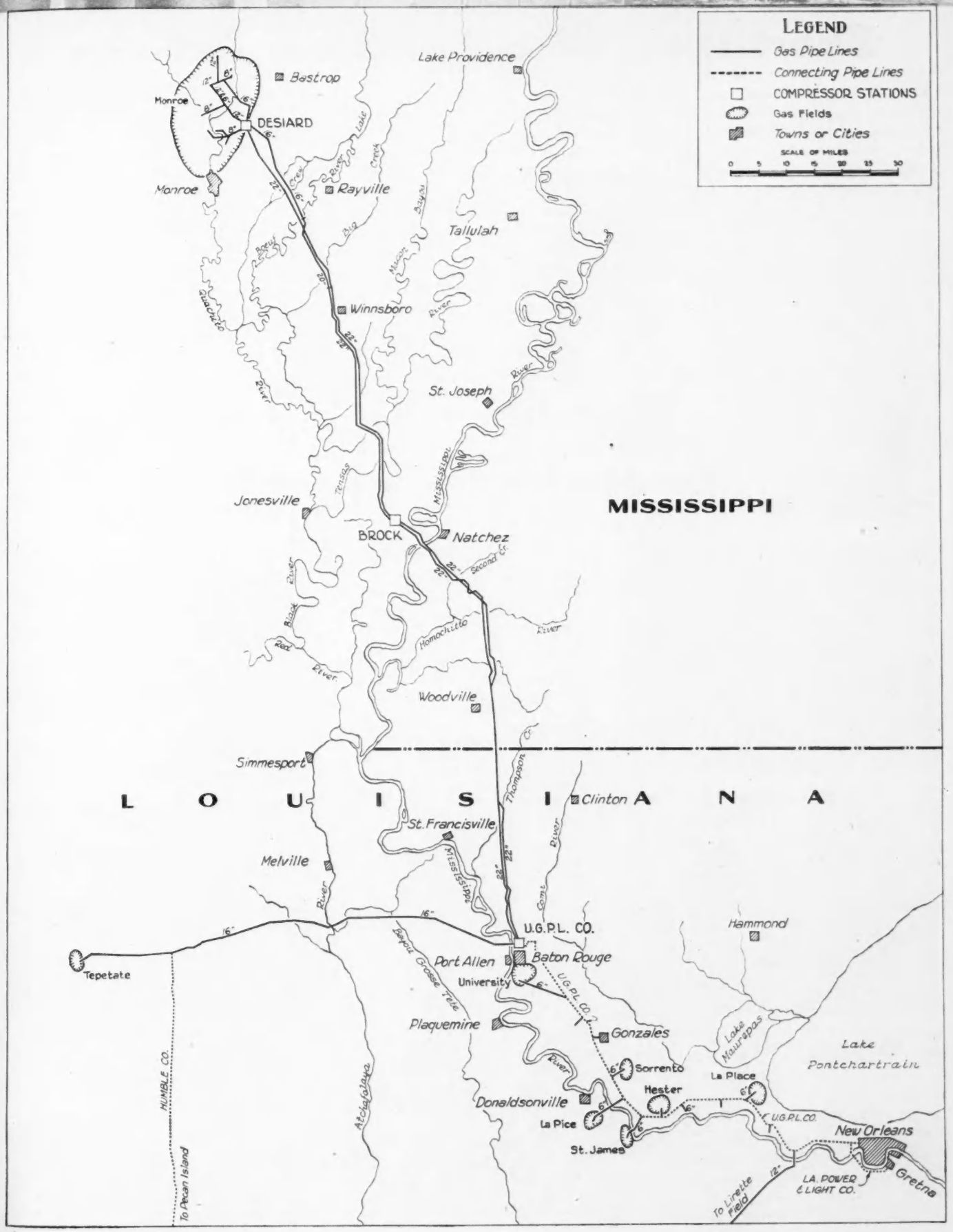
Since the Tri-State proved that radar can help pilots navigate through fog—the greatest enemy of river transportation since the first steamboat came down the Ohio in 1811—other leading barge lines have acted to place the equipment aboard their boats. Radar has also overcome the poor visibility caused by heavy smoke, extreme darkness, rain, and snow. Many river navigators have described radar's adaptation to use on the Ohio-Mississippi system as constituting one of the biggest advances ever made in river navigation.

The revolving scanner is at the top, with its mechanism and the connecting wave guide directly below. In the background is the "A" which lights at night when the air horn is sounded; and the aerial for the radio telephone system.

Arkansas-Louisiana Gas Company



Interstate Natural Gas Company



PIPE LINE *Construction*

Shortages, Weather Slow Activity

WITH pipe line transportation of crude and gas in greater volume than in 1946, and with Federal Power Commission studies indicating that a huge increase in interstate transportation of natural gas will follow the construction of projects authorized in 1947, the 2800 miles of pipe line spotlighted in the past month's reports of activity showed companies and constructors handicapped by shortages and weather. The month also saw the beginnings of large projects that, under present conditions, will not be completed within the next year.

The most important project to get under way was Michigan-Wisconsin Pipe Line Company's line to carry Texas Hugoton gas to Michigan. Though Panhandle Eastern Pipe Line Company protested, FPC approval was granted and construction promptly began at the origin and terminal of the line. Both spreads are being handled by J. R. Horrigan Construction Company of Houston. The Austin Field Pipe Line Company is building a line to carry the gas from the Big Rapids, Mich., terminal on to Detroit. The completed project will carry an estimated 350 million cubic feet of gas north each day. Michigan will get more gas as Panhandle Eastern Pipe Line Company proceeds with its large looping projects, and new lines are constructed by Michigan Consolidated Gas Company and the Austin Field Pipe Line Company, to store Panhandle gas for use in the Detroit area.

Colorado-Wyoming Gas Company started construction on its Denver-Cheyenne line to carry Hugoton gas from the Kansas part of the field into the Rocky Mountain area. The gas is delivered to Denver by Colorado Interstate Gas Company's recently completed line. The line now being constructed by Pacific Pipeline & Engineers, Ltd., parallels an eight-inch line to Cheyenne.

December was the month when California became an importer of gas, as El Paso Natural Gas Company completed the final spread on the West Texas-Blythe, California, "Biggest Inch" line.

Steady progress was noted on the Basin Pipe Line Company's crude trunk line from —al, N. M., to Cushing, Okla.

Pipe Line Construction Activity

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size, (Inches)	Daily Capacity (Bbls., Cu. Ft.)	REMARKS
CRUDE OIL LINES					
Anglo-Iranian Oil Co., Ltd.	Agha-Jari field to Mashur, head of Persian Gulf, Iran	28 28	20 22	....	Reported planned for use in increasing exports in 1949; company will handle all construction.
Arabian American Oil Co.	Abqaiq field to Ras Tanura refinery, Saudi Arabia	61	20 & 22	.....	Construction under way; company using own equipment and men.
Basin Pipe Line Co. (The Texas Pipe Line Co., Shell Pipe Line Co., Empire Pipe Line Co., Sinclair Pipe Line Co.)	Jal, N.M., to Midland, Texas Wichita Falls, Texas, to Cushing, Oklahoma	67 173	20 24	....	Contract expected to be awarded in January; 173-mile section later. These are two sections of 500-mile project from Jal to Cushing. Latex Construction Co., Houston, laying 253-mile Midland-Wichita Falls section.
Graco Oil Refining Co.	Mushcreek field to Newcastle refinery, Weston Co., Wyo.	10	6	.....	Company reported arranging to construct outlet for field.
Gulf Refining Co., Houston Pipe Line Division	Lufkin to a point west, West Texas System Elkhart to Wortham Wortham to Grandview	18½ 10¼ 5¼	10 10 10	....	Completed. Completed. Pipe received. Construction under way by Smith Contracting Co., Ft. Worth.
	Grandview to Weatherford Ranger to Clyde Clyde to Sweetwater	3½ 10½ 12	10 10 10	.....	Pipe due in December. Smith contracting Co. will construct.
	Sweetwater to Coahoma Coahoma to Midland Lucas to Port Arthur Lufkin to Chester Sour Lake to Port Arthur	10 11¼ 11 9 1/10 14⅘	10 10 10 8 10	.....	Pipe due in February. Smith Contracting Co. will construct.
Imperial Oil, Ltd.	Near Montreal, Canada	4 10 20 7	12 16 8 6	....	Williams Brothers Co., Tulsa, constructing line; to complete early in 1948.
Interstate Oil Pipe Line Co.	Loop near Natchez, Mississippi	18	10	.....	Completed in December by Latex Construction Co., Houston.
	Maysville field, Garvin County, Okla., to company's Oklahoma City pump station	45	12	.....	Construction started by Mid-Western Constructors, Tulsa. Line will provide additional capacity for increasing production in the county.
Iraq Petroleum Co.	Kirkuk field, Iraq to Haifa, Palestine	620	16	120,000	Completion, scheduled for December, delayed.
Mid-Continent Pipe Line Co.	St. Louis, Okla., to Elmore City, Okla.	47	6	.....	Construction completed by C. P. Carter Construction Co., Seminole, Okla. One pump station at Maysville; relays crude to main line at Seminole.
Pan-American Pipe Line Co.	Gathering system in Dirks, Pettus, S. Caesar, N. Pettus and Tulsita fields, Bee and Karnes counties, South Texas.	24⅗	4 & 6	.....	System completed in December.
Root Petroleum Co.	Ora field to El Dorado, Ark.	26	6	.....	Construction completed by the Snelling Co., Shreveport.
Socony-Vacuum Oil Co.	Adel field, Sheridan Co., to Morel field, Graham Co., Kans.	7	.....	.....	Company announced planned construction.
Sunray Oil Co.	From the Texas Co.'s Velma station to Duncan refinery, Oklahoma.	17	8	25,000	Company announced plans to construct.

■ TABLE CONTINUED ON NEXT PAGE

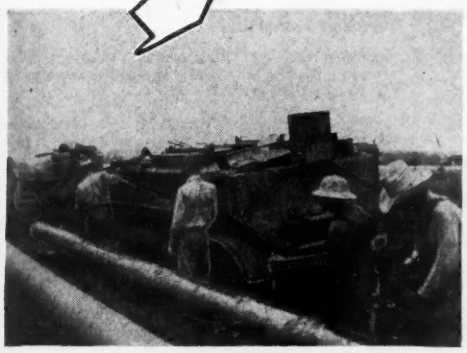
HERE'S WHERE "PIPE-LINE KNOW-HOW" *Pays off!*

O. R. SMITH
president

F. A. SMITH

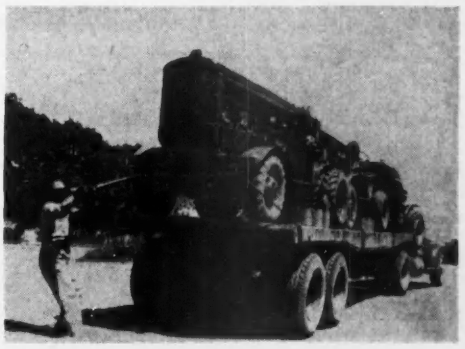
J. H. SMITH

QUAY MARTIN
office manager

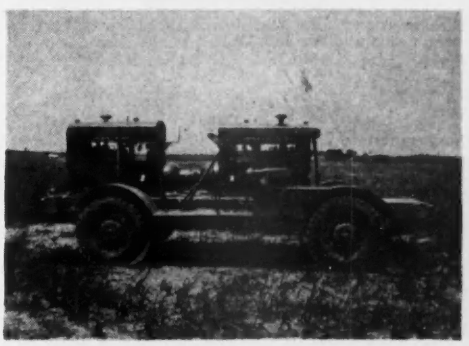


SMITH'S PORTABLE EQUIPMENT SAVES TIME AND MONEY!

Using self-propelled dope pot and other self-propelled portable power units shown here, Smith is effecting savings up to 30 percent—increasing production up to 30 percent! Job shown here is the 12-inch pipeline now being constructed from Beaumont to Hearne, Texas. (Left) Smith self-propelled dope pot in action. (Right) Air compressors, mounted on self-propelled trailers, in transit.



Shown here (left), Smith portable tacking rig and self-propelled dope pot—easy to move—on the job in a hurry! (Right) Close-up view of Smith tacking rig. All units pictured now in actual use on 12-inch Beaumont-Hearne pipeline.



All self-propelled units illustrated are manufactured by O. R. Smith Mfg. Co., Fort Worth.

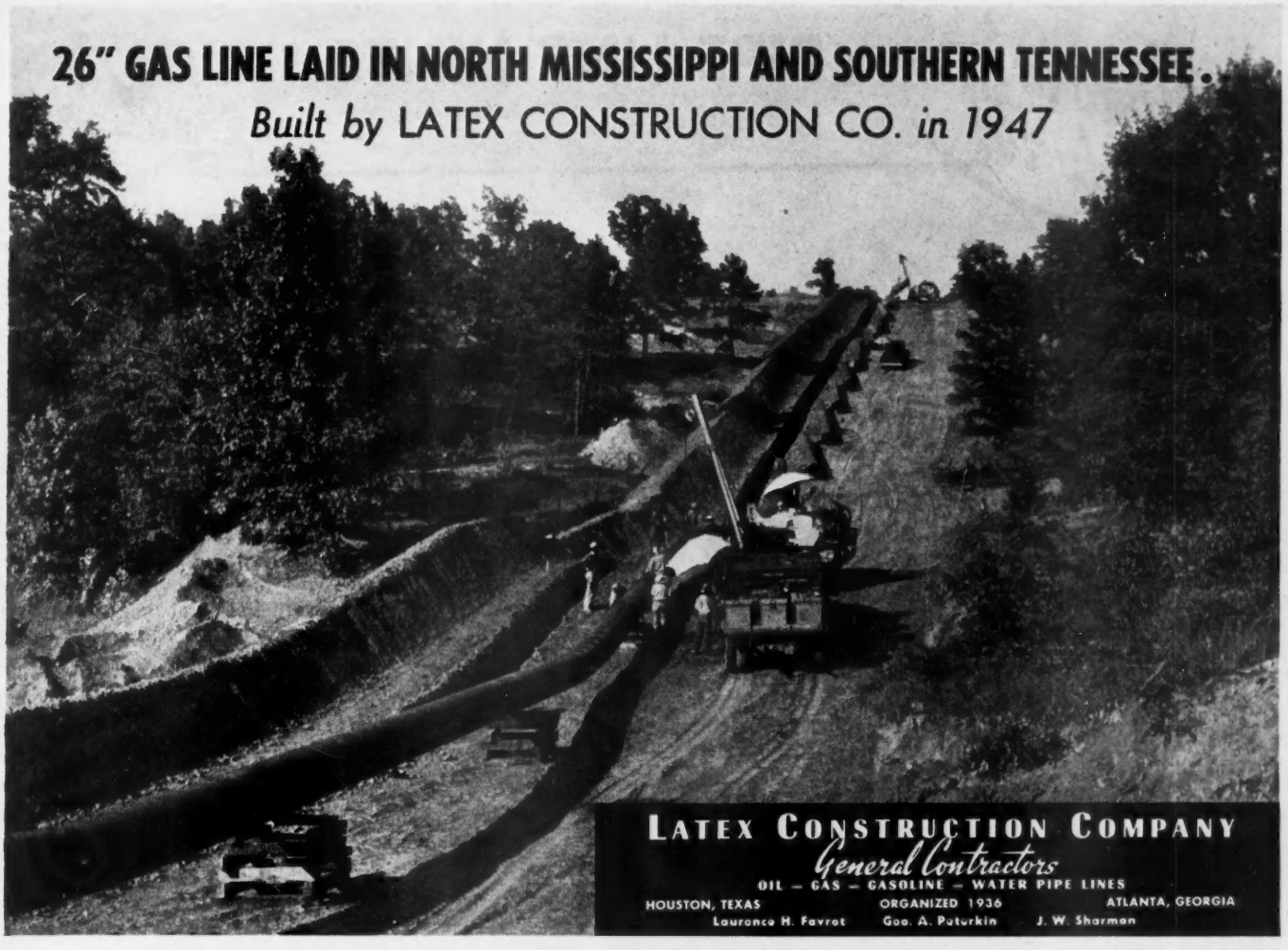
Smith

CONTRACTING CORP.
ODESSA, TEXAS
MAIN BUSINESS OFFICE
FORT WORTH NAT'L. BANK BLDG.
FORT WORTH 2, TEXAS

Pipe Line Construction Activity

(CONTINUED)

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size, (Inches)	Daily Capacity (Bbls., Cu. Ft.)	REMARKS
PRODUCTS LINES					
Connecticut Pipe Line Corp.	New Haven to Hartford, Connecticut	40	8	19,150	Plans being completed to start construction in Spring, 1948.
The Texas Pipe Line Co.	Hearne to Austin, South Texas	79	8	.....	Contract awarded to Latex Construction Co., Houston; work to begin shortly after January 1, 1948. This is part of the Beaumont-Hearne-Dallas system, which is about half completed.
	Austin to San Marcos	28	6	.....	
NATURAL GAS LINES					
Alabama-Tennessee Natural Gas Co.	T-G-T trunk line, near Middleton, Tenn., to Tuscumbia, Alabama	75	12	30.4 mln	Application before FPC. Line expected to serve north Alabama, northeast Mississippi and southwest Tennessee for about 5 years.
	Tuscumbia to Decatur, Alabama	35	8		
	Decatur to Huntsville, Alabama	26	6		
Arkansas Western Gas Co.	Cass Mt., Franklin Co., Arkansas	11	8	.....	Construction completed in December by Worth James Construction Co., Little Rock, Ark. Estimated line cost $120,000.
Cities Service Gas Co.	Guthrie, Okla., to Drumright station, Creek Co.	12	16	130 mln	Cross-over line to bring gas from west to east side of system. Cost $881,000. Listed facilities authorized by FPC total $1,490,683. Project not expected to be completed in 1948-49 period because of shortages. Tallant-Hogshooter 19-mile 12-inch line being taken up and replaced with shorter route. Some facilities south of Drumright station being abandoned.
		34	12		
	Connection to Consolidated Gas Utilities Corp.'s line in Grady Co., Oklahoma	10½	16		
	Tallan-Hogshooter line replacement	15½	16		
Colorado-Wyoming Gas Co.	Mesa, Adams Co., (Denver), Col., to Cheyenne, Wyo.	90	8	.....	Contract awarded to Pacific Pipeline & Engineers, Ltd., Los Angeles. Scheduled to complete April 1, 1948. Cost $1,500,000. Under construction.
		11	16	20 mln	
Continental Oil Co.	Tepetate field to Westlake (Lake Charles, La.)	50	14	.....	Construction completed in December by Eastern Construction Co., Dallas.
Cumberland & Allegheny Gas Co.	Terro Alto, W. Va., and Oakland, Md.	7	6	.....	Application before FPC. Estimated cost $130,269.
Dow Chemical Co.	Near Bay City, Texas Gulf Coast	18	4	.....	Gathering and transmission system completed by Latex Construction Co., Houston, in December.
		28	12	.....	
Empire Southern Gas Co.	Shafter Lake field, Andrews Co., to El Paso Natural Gas Co.'s Fullerton station, West Texas	10	8	10 mln	Contract not awarded; company expects to receive pipe last of December or early January. Estimated cost of project $100,000.
El Paso Natural Gas Co.	Keystone field to Jal, N.M.	13	14	.....	Completed.
Home Gas Co.	Hancock to Cohocton, N.Y.	26⅞	12	.....	Application before FPC. Lines and additional facilities to cost estimated $1,850,155.
	Horseheads to Dundee storage field, N.Y.	25	10	.....	
The Hope Natural Gas Co.	Loop to 90-mile line between Cornwell and Hastings stations, W. Va.	26	14	.....	Application before FPC. Line, plus additional horsepower, to cost estimated $1,480,000; increase 165 mln capacity by 35 mln cu. ft. per day.
Houston Industrial Gas Co.	Yoakum field to El Torro, South Texas	37	10	.....	Contract awarded to C. W. Sternberg, Houston; scheduled completion February 1, 1948.
Kansas-Nebraska Natural Gas Co.	Gathering system in Pawnee Co., Kans.	8½	6	.....	Completed by R & G Pipeline & Construction Co., Russell, Kansas.
Manufacturers Light & Heat Co.	Connections with main TET line	7½	14	.....	Application before FPC. Facilities include additional horsepower at Waynesburg compressor station. Estimated cost $709,740. Company proposes to sell Rosbys Rock and Beallsville compressor station units because of decreasing production.
	Compressor station, Chester Co., Pa.	.....	.....	.....	
Michigan Consolidated Gas Co. and Austin field Pipe Line Co.	Eastern terminal of Austin-Detroit line to Melvindale, Mich.	.....	26	.....	Application approved by FPC. Cost of Michigan facilities estimated $1,174,000; Austin, $8,151,000. Michigan will lease and operate Austin facilities.
	Austin storage field to point near Detroit	140	26		
Michigan-Wisconsin Pipe Line Co. and Austin field Pipe Line Co.	Hansford County, Texas Panhandle, to point north of Hutchinson, Kans.	225	24	.....	Contract for two spreads awarded to J. R. Horrigan Construction Co., Houston. Beginning of 1069-mile 22 & 26-inch line from Hugoton field to Michigan, Austin Co. building Big Rapids-Detroit terminal line. Project scheduled to be completed in 1950. Horrigan field office in Guymon, Okla., and Owosso, Mich.
	Big Rapids to Detroit, Mich.	130	24		
Northern Natural Gas Co.	Gathering lines in Gray and Carson counties, Texas Panhandle	3½	4	.....	Contract awarded to W. M. Davidson Construction Co., Pampa, Texas; completion scheduled for January, 1948.
		8¾10	6		
		5⅛	8		
	S. Sioux City to Rosalie, Neb.	50	18	.....	Loop completed by Eastern Construction Co., Dallas.
	Fremont to Schuyler, Neb.	30	6	.....	Loop completed by McVean & Roberts Pipe Line Construction Co., Odessa, Texas.
Northern Natural Gas Co. and Minnesota Natural Gas Co.	Lakefield to Worthington, Minn.	33	6 & 4	.....	Construction completed by McVean & Roberts, Odessa.
Southern Natural Gas Co.	Loops near Birmingham, Ala.	19	20 & 22	.....	Construction completed by Latex Construction Co.
	Gwinville field, Jefferson Davis Co., Miss.	9	6 & 8 12	.....	Construction completed by Latex Construction Co., Houston.
United Gas Pipe Line Co.	W. Lake Verret field to Oaklawn, La.	9	8	.....	Contract awarded to Brown & Root, Inc., Houston, Construction started.
		5	7	.....	
	Whistler Junction (Mobile) to point near Saraland, Ala.	9	16	.....	Contract awarded to B. & M. Construction Co., Oklahoma City. Construction started.
	From Carthage-Sterlington 24-inch line, Jackson Parish, to point near Hodge, La.	6	6	.....	Construction under way by L. E. Favley, Houston. Scheduled to complete December 20.
United Natural Gas Co.	Compressor station in Beaver Co., Pa., near Ellwood City connecting line from company's 12-inch line in Beaver Co., to TET's Big Inch line in Greene County, Pa.	71	20	.....	Compressor station being built by Blaw-Knox Co., Pittsburgh, chemical plants division; line by Williams Bros., Tulsa. Both expected to be completed by first week in 1948. Estimated cost of line $3,570,000.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LATEX CONSTRUCTION COMPANY
General Contractors
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PIPE LINE HINTS

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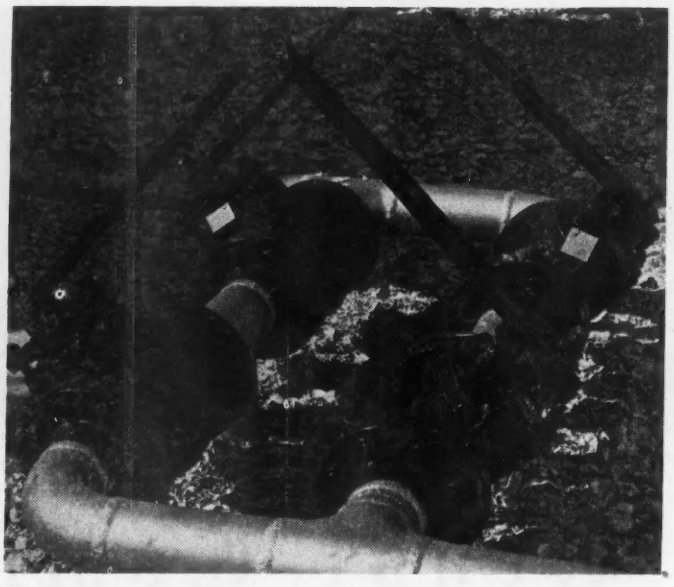
How To— Install Plug Valves on Manifold Lines for Easy Operation

Where tank batteries are grouped in rows at relatively close intervals, the intake and discharge lines can be grouped together for maximum efficiency in operating control with a resultant saving in the amount of pipe required. To reduce the necessity of coating and wrapping the pipe, both the lines and control valves were located above ground.



The intake and discharge manifold lines, in the case illustrated, are buried below ground. For convenience and space-saving reasons, the valves have been grouped together as shown. In setting the valves, there was the choice of installing them in an upright position or that shown. However, if the valves were mounted on the line in a vertical position, the switcher would be required to squat quite low in order to manipulate the valve lever. By installing the valves at a 45-degree angle, with opposite valves set 90-degrees apart, not only were the control levers free to turn, but the switcher could operate the valves from a stooped position, thereby giving him more pulling power than from a squat position.

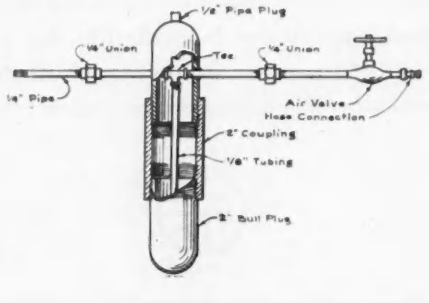
By leaving the control levers on the valves at all times, the switcher can determine at a glance whether the valves are open or closed. Where one man is required to tend several tanks in a battery, such an installation will save him time and reduce some of the strain in manipulating the valves.

How To— Dislodge Stuck Valves on High-Horsepower Gas Engines

When exhaust valves on large gas engines become stuck open due to carbon and rust, the common method to unloosen the valve has been to dismantle the valve port and make replacements. On some engines this is a four-hour job. To obviate the situation when exhaust valves do become stuck open is a device called the Exhaust Valve Air Lubricating Gun, designed by two station engineers.

Purpose of the gun is to force a mist of light lubricating oil into the exhaust valve port to lubricate the valve stem and bushing. Light oil or kerosine is forced into the exhaust valve chamber by compressed air under 150 to 200 pounds per square inch pressure. The lubricant penetrates the carbon and rust to help free the valve, thereby eliminating a costly maintenance job.

The gun consists of two, two-inch bull plugs screwed together with a two-inch coupling. The piping consists of: one ¼ x 18-inch pipe to connect to the exhaust valve stem oiler; two ¼-inch unions; two ¼ x 4-inch nipples; one ¼-inch tee; two ¼ x 6-inch nipples; one ¼-inch gate valve; and one air hose connection. The fittings are assembled according to the diagram. Inside the vertical riser of ¼ x 18-inch pipe which fits inside the container made from the two bull plugs, is a section of ⅛-inch copper tubing. It is drawn at the bottom end to form an opening about 1/16-inch in diameter. At the upper end it is cut at a 45-degree angle and inserted inside the ¼-inch pipe so that the angle cut extends into the air stream and the angle faces down stream.



The lubricating oil or kerosine is poured into the container through a ½-inch pipe plug in the top bull plug. Air passing through the air line creates a vacuum in the ⅛-inch copper tubing and the lubricating medium is drawn into the air stream in a mist. This mist is forced into the exhaust valve chamber where it does its work.

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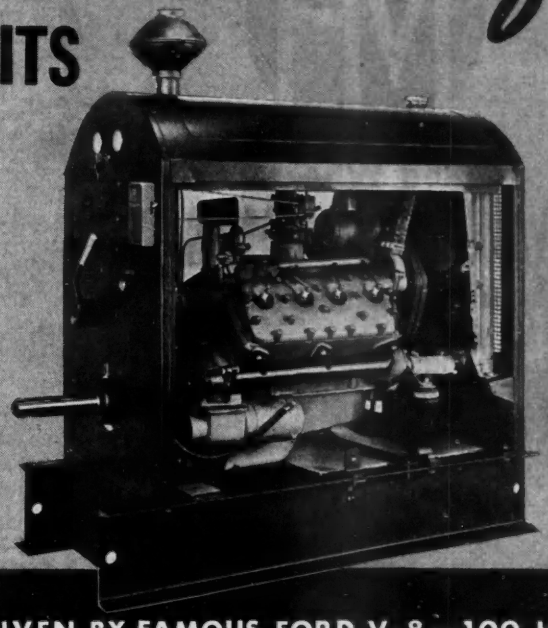

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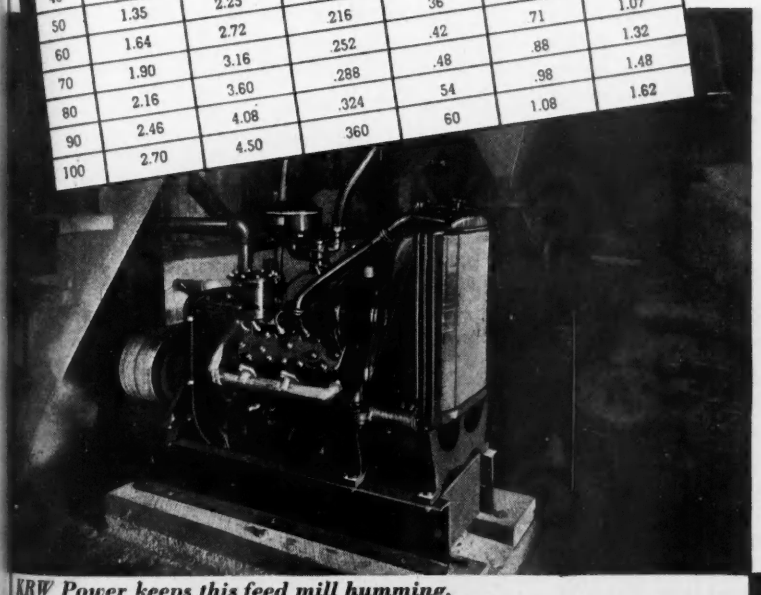
	$ .03	$ .05	$ .30	$ .50	$ .10	$ .15
15	.41	.68	.054	.09	.19	.29
20	.54	.90	.072	.12	.25	.38
25	.68	1.13	.09	15	.30	45
30	.82	1.36	108	.18	.34	.51
35	.95	1.58	.126	.21	.39	.59
40	1.08	1.80	.144	.24	.44	.66
45	1.23	2.04	.162	.27	.49	.74
50	1.35	2.25	18	30	.54	.81
60	1.64	2.72	.216	36	.63	.95
70	1.90	3.16	.252	.42	71	1.07
80	2.16	3.60	.288	.48	.88	1.32
90	2.46	4.08	.324	54	.98	1.48
100	2.70	4.50	360	60	1.08	1.62



KRW Power keeps this feed mill humming.

STUDY THIS CHART IN TERMS OF YOUR INDIVIDUAL NEEDS

The table above shows the comparison of operating costs per hour for (1) Electric Motor, (2) KRW Unit operating on natural gas and (3) KRW Unit operating on gasoline. For dependable, constant-duty power, we recommend an engine speed not to exceed 2250 RPM and that only two thirds of the B. H. P. developed at any given speed should be used. Thus at 2250 RPM the engine develops a maximum of 64 B. H. P. on Gasoline and 55 B. H. P. on Natural Gas. This is usable Horsepower, available for short periods only. Two thirds of this or the constant duty power would be 43 B. H. P. and 36 B. H. P. with Gasoline and Natural Gas respectively. By using only two thirds of the maximum available Horsepower, reserve power is maintained for variations in fuel, lubricating oils, adjustments, ignition and climatic conditions. (There is a 3 to 5 per cent power loss for each 1000 feet of altitude.)

For highest efficiency, long engine life and economy, an engine speed of 1800 RPM has proven most satisfactory. Ford V-8 Engines are so highly developed and perfectly balanced, that an operating speed of 1800 RPM is recommended regardless of the Horsepower to be used.

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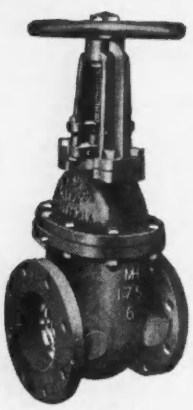
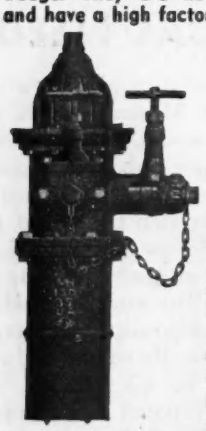


M & H valves are used in the oil industry for water, gas, steam, oil, chemicals and are furnished in all commercial sizes from 2" to 30", inclusive. They are cast iron body, bronze mounted, furnished double disc parallel seat or solid wedge. They are heavily proportioned and have a high factor of safety.



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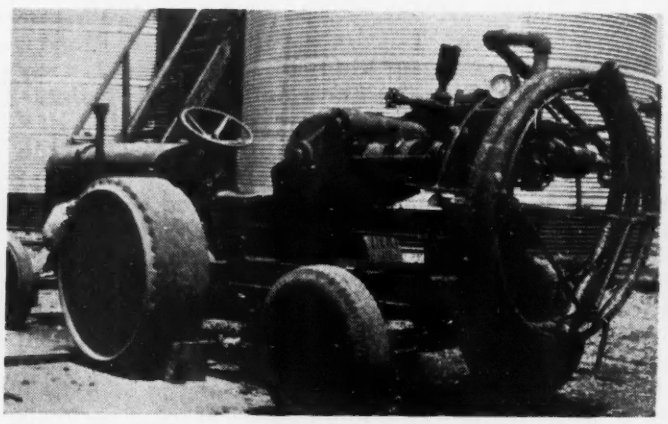
How To—Design Utility Pump Trailer



For occasional or emergency pumping of oil from one tank to another to clean sumps and settling basins, or to perform other odd jobs requiring the transfer of liquids, a mobile pump of the design illustrated has been found to be of material assistance to the crew at one tank farm. A two-wheeled trailer was constructed from I-beams and channel iron and mounted on an automotive-type axle. The pump was bolted to an elevated framework so the power take-off from the tractor could be used to drive the pump. The pump was fitted with check valves, pressure gauges, and a manifold so that oil, water or other liquids could be pumped through the tank farm manifold, or from a sump to a tank truck, or where desired.

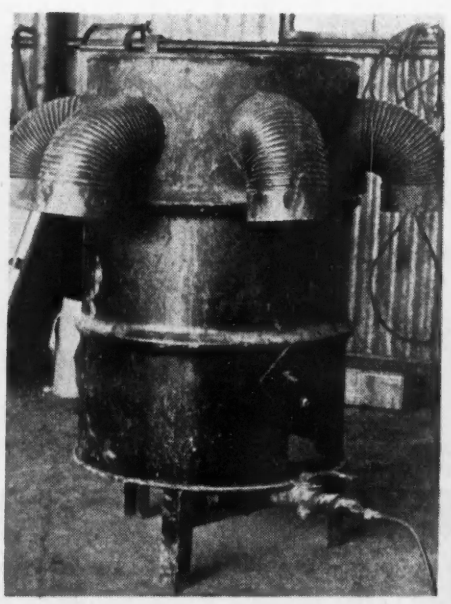
Utility of the mobile pump trailer was increased by the unique circular rack provided to carry the suction hose. It was made from one-inch pipe and welded to the trailer frame. Not only does it make the hose readily available, but it also eliminates much of the wear and tear received by this type equipment.

How To—Construct Inexpensive Shop Heater

Efficiency is materially lowered when maintenance and repairmen must work in cold shops. Gas is usually available at every compressor or pump station in the area and an easy-to-build shop heater can be quickly assembled from miscellaneous parts around the station. One such home-made heater is shown and illustrates the ingenuity of one shop foreman.

This simple but effective heater was constructed from an empty steel drum, six stove pipe ells, a gas burner, copper tubing, pipe fittings and some angle iron. A triangular frame was first made from 1¼-inch angle iron elevated from the concrete floor by three angle-iron legs six inches long. The drum was set over the framework, a portion of the drum's bottom removed and the burner installed. A three-inch by four-inch hole is cut in the side of the drum and equipped with a swing door to provide a means of lighting the burner.

Six holes cut radially about the sides of the drum permitted the hot gases to escape the heater. Stove pipe ells, welded to the drum to cover these ports, direct the hot gases downwards so that maximum utilization may be gained from the heater. A one-inch plug-type valve controls the burner flame to any desired degree of heat. Equal distribution of heat completely around the unit is obtained from the ports, and adequate heating of relatively large shops is provided by one such heater.



LOCKETT-WORTHINGTON
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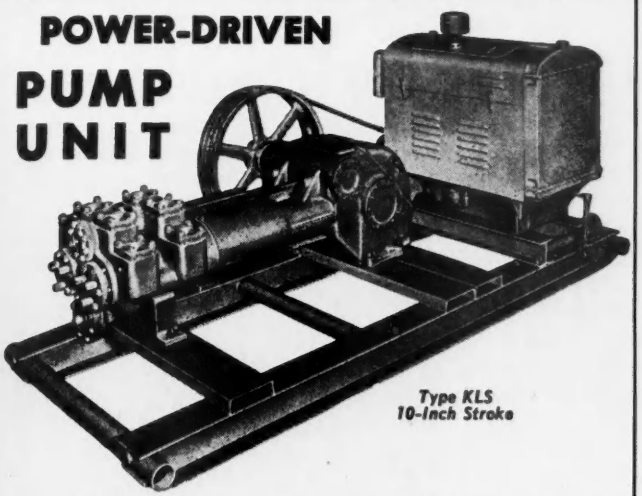

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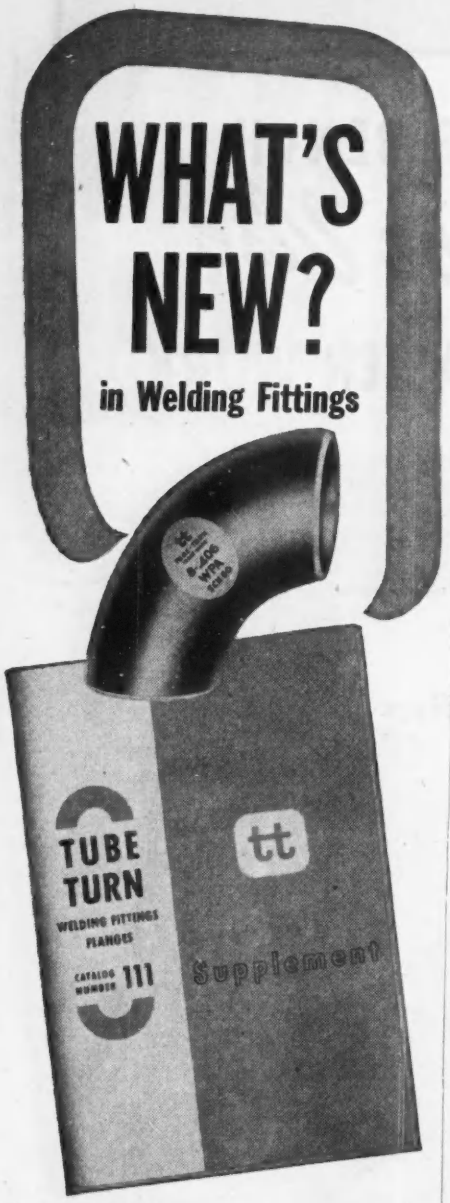

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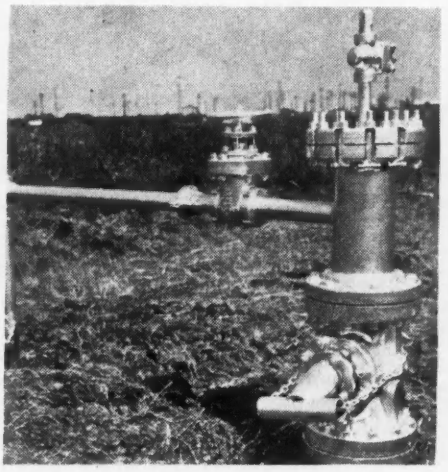
How To— Reduce Strain on Valves by Equalizing Line

Where block gates are used on main line gas transmission systems, much strain on the main valves can be eliminated if the line pressure is partially equalized on both sides before the valves are opened. Instead of carrying the usual by-pass line around the block gate in the gate pit, one company uses a line above ground, where the by-pass may be isolated by the main blow-down valve set on a riser just ahead of the block gate.

The by-pass valve, shown on the horizontal run, carries line pressure only when the valve shown vertically is opened. This valve is kept closed, and a guard and chain provided to halt unauthorized manipulation.

The valve shown at the top of the spool which carries the by-pass line is for a gauge, used when equalizing line pressures. A plug is kept inserted in the upper threads of the valve, to exclude moisture and dirt.

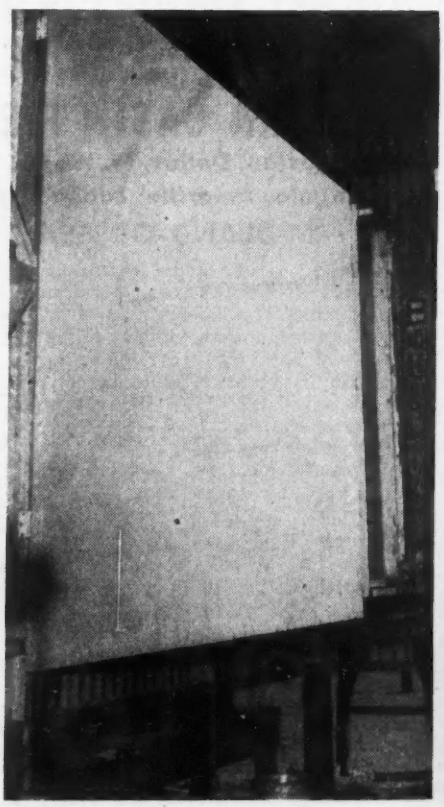


How To— Provide Fresh Air Circulation for Radiator

Small pump stations housing engine-driven pumps which take the oil from lease tanks and force it into pipe lines at the line pressure suffer excessive heat in the summertime. This heat inside the pump station building is created by the dissipated heat from the radiator and that from the engine itself.

To lower the heat in the station during the summer months, one superintendent devised a radiator exhaust duct as illustrated. A reverse blade fan is employed so that air is blown through the radiator instead of being drawn through the radiator into the engine housing. To eliminate recirculation of the air inside the station building, a wooden duct made from ¾-inch plywood was installed so that the air blown through the radiator by the engine fan was discharged outside the building. A framework was built around the radiator grill and plywood sheets were nailed to this framework and to the building wall to form a closed channel as shown. The exhaust area through the building wall was approximately twice that of the radiator grill so that little resistance was offered to the exhausting air.

Additional measures were taken to reduce the room temperature by screening in the lower 18 inches around the station house. This opening permitted ample cooling air to enter. If winter temperatures become too severe, these openings could be boarded up. In extreme cold weather, too, the wooden duct could be removed from the radiator, each side being hinged to the wall for convenience of dismantling. These measures were inexpensive and have proven quite effective.

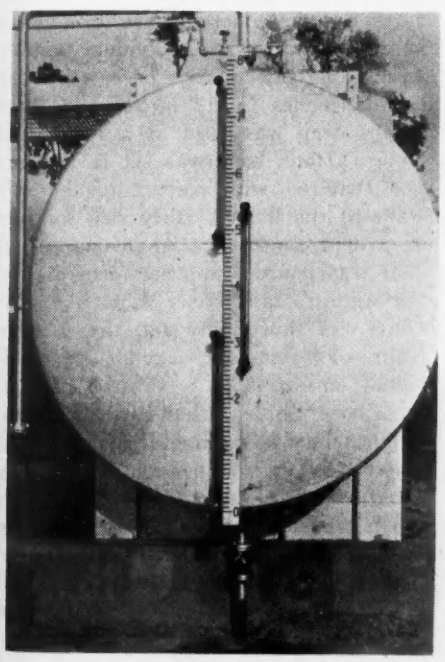


How To—

Indicate Oil Level in Lubricant Storage Tank

Considerable savings are derived from bulk purchases of lubricating oil for pipe line compressor station consumption. It is the practice of one pipe line company to buy its lubricating oil for one station in tank car lots. The lubricating oil is stored in horizontal tanks located adjacent to a railroad spur.

To permit a day-to-day check on the volume of lubricating oil in stock, one end of each tank is equipped with gauge glass indicators. Each indicator consists of three gauge glasses 2½ feet long, each end of which is tapped into the storage tank. The center gauge glass is offset from the remaining two by a distance of about six inches to permit one continuous indicating board to be attached to the tank between the gauges. This gauge board indicates feet and inches of lubricating oil in the tank, which measurement is facilitated by this construction as compared to the individual indicating sticks along side each gauge glass. The six-inch overlap of the three gauges is more than adequate to give accurate results in determining quickly the oil level inside the tank. Size of the board is such that large numerals can be printed on its surface and can be read from a distance.



***It Is Enabling 3 Million Fewer Farmers To Harvest Food From 20 Million More Acres**

War service and war work thinned the ranks of American farmers by 5 million. There still are 3 million fewer farmers than in 1940. Yet, since 1940, farm production has increased one-third.

Hard work and good weather helped. But, this Bunyanesque feat of production could not have been accomplished had it not been for the mechanization of farms.

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Vastly increased farm mechanization has taken place in the last ten years. In that time the composite price of finished steel, as published by Iron Age, has increased only about ½¢ per pound. This modest increase in the base price of steel as obtained by the mill has little effect on the ultimate cost to the consumer of steel products.

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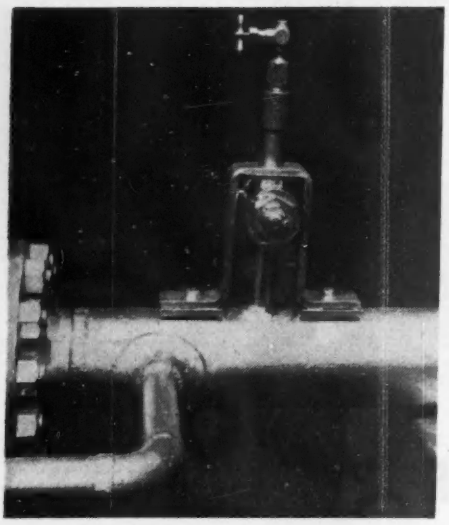
How To—

Stiffen Pipe Line Pressure Gauge Taps



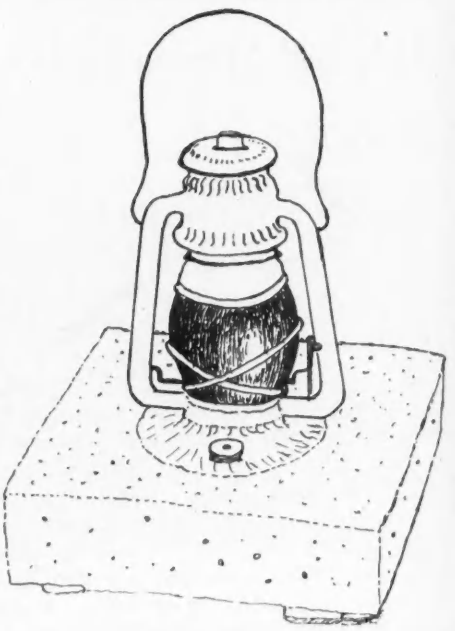
Fittings for gauges on high-pressure gas lines are usually welded to the flow line on a built-up fillet to provide extra strength at the junction of the one-inch branch and the main. It is usual practice to use a quarter-turn plug valve below the needle valve above which is mounted the gauge.

If the plug valve is hard to turn, considerable bending force is applied to the nipple, and the weld may be overstressed. One company protects the valve by placing a guard over the branch, just above the valve. The brace is made from ½x3-inch bar steel, formed in a flat "U" with extended tips parallel to the base of the "U." Pads of the same material are welded to the flow line pipe wall, having set in them ¾-inch bolts with the threaded ends up.

The brace is designed to align with the pads, and to fit closely around the one-inch gauge line. When the brace is pulled down into place with the bolts in the pads, it stiffens the tap line so that a "cheater" may be used on the plug valve wrench in complete safety. The brace also protects the welded junction from end thrust as the plug valve is exposed, when closed, to unbalanced pressure from the gas below it.

How To—

Weight Warning Lanterns



When pipe line construction or repair work necessitates the crossing of highways or streets, some sort of visual warning markers are usually required to direct night traffic away from open ditches, excavations, piles of loose dirt, etc. The conventional kerosine, wick-burning lantern when equipped with a red glass usually serves such purposes quite satisfactorily. But an undesirable feature is that such lanterns are easily upset unless suspended by the bail.

One pipe line contractor added stability to his warning lanterns by pouring a rectangular concrete base around the kerosene tank of the individual lantern. In molding the concrete base, a wooden box 12 inches by 12 inches and three inches deep was used as a form. The lantern's tank base was set in the box and centered with respect to the side walls of the box. A fairly rich mixture of cement, sand and a small quantity of chat was poured into the form around the lantern's tank base. When the concrete was thoroughly set, the wooden form was removed, leaving the individual lantern with a substantial concrete base molded around its base tank.

The salient advantage of such warning lanterns is that with such bases, they are considerably more heavy, hence they are not easily upset. Furthermore, the incident of lantern pilfering was found to be practically non-existent, for small boys and petty thieves apparently found such objects too weighty and cumbersome to make way with at night.

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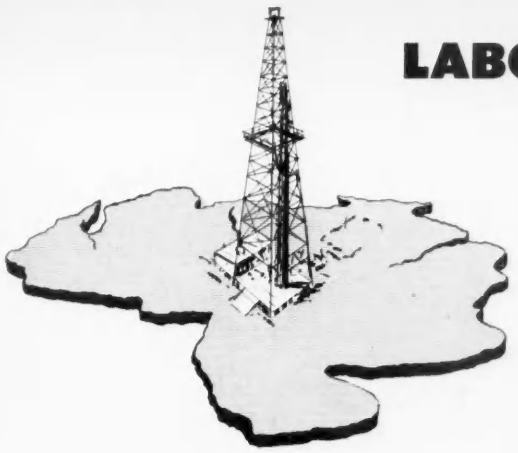


LABOR AND Venezuelan Petroleum

By GEORGE O. IVES
Foreign Editor

FOLLOWING a period of comparative quiet since agreement upon the collective labor contract of mid-1946, the petroleum industry approaches negotiation of a new pact with Venezuelan workers facing much the same problems existing elsewhere in the world. Labor's demands are certain to increase production costs, and there is a tendency toward efforts to take a hand in policy and management affairs.

OIL operators of Venezuela were giving considerable thought toward the close of the year to the forthcoming negotiations for a new contract with organized petroleum workers of Venezuela, and were taking a rather grave attitude toward preparations for discussions with labor representatives.

At the same time the new labor law was being studied with a view to analyzing its net effect and possible implications. As a whole, the new law, plus demands almost certain to be made by workers, bid fair to further complicate operations and to materially increase cost of finding, producing, transporting and refining oil.

A significant pattern runs through the histories of labor legislation and of labor-management relations. In contracts arrived at through collective bargaining labor always receives benefits . . . social and economic as well as remunerative . . . beyond those prescribed by law. Subsequent labor legislation then incorporates these benefits, or many of them, into new laws which make them mandatory, and succeeding labor-management negotiations result in additional concessions on the part of management.

Recent trends have been demands for various economic benefits rather than actual wage increases, and figures maintained by Venezuela's foreign oil operators show that these have now reached a point where their actual value is greater than the actual amount of wages paid in cash.

Although labor in all industries in Venezuela is seeking advancement, the petroleum industry is being used as an entering wedge. It has been remarked by those associated with administration of the government's labor policies that the attitude of labor and its advisors is to plant the new demands for social and economic advantages first in the petroleum industry, because it doesn't fight back. Labor feels that the industry's position is such that it cannot but submit. Actually, the policy is a result of shrewd trading on the industry's desire to increase the social, health, and economic standards of its employes in whatever country it operates. It feels it must submit for the public good and leave part of its profits in the country.

A point brought out by students of the situation is that the Venezuelans, in pointing such statutes at the petroleum industry, is writing benefits into the laws which will force the other industries to comply, and may ultimately have to give aid to those who cannot afford the increased costs attendant upon compliance.

Another Complication

Although it is certain there will be differences between labor and management as the result of the new law and the expected demands for the new collective contract, the situation is further complicated by an important unknown factor. This is the new governmental administration almost certain to be in power at the time when negotiations between labor and management are still under way. Elections were scheduled December 14, but apparently the constitution does not specifically state just how much time should elapse between election of the new administration and the time it takes over officially. The congress must convene to ratify the election results, and it probably will announce at that time the date the administration goes in.

The committee of the Federation of Petroleum Workers of Venezuela was preparing to go into session for the purpose of drawing up its petition of demands for presentation to the formal workers' session. Originally scheduled for November 14, the meeting was postponed.

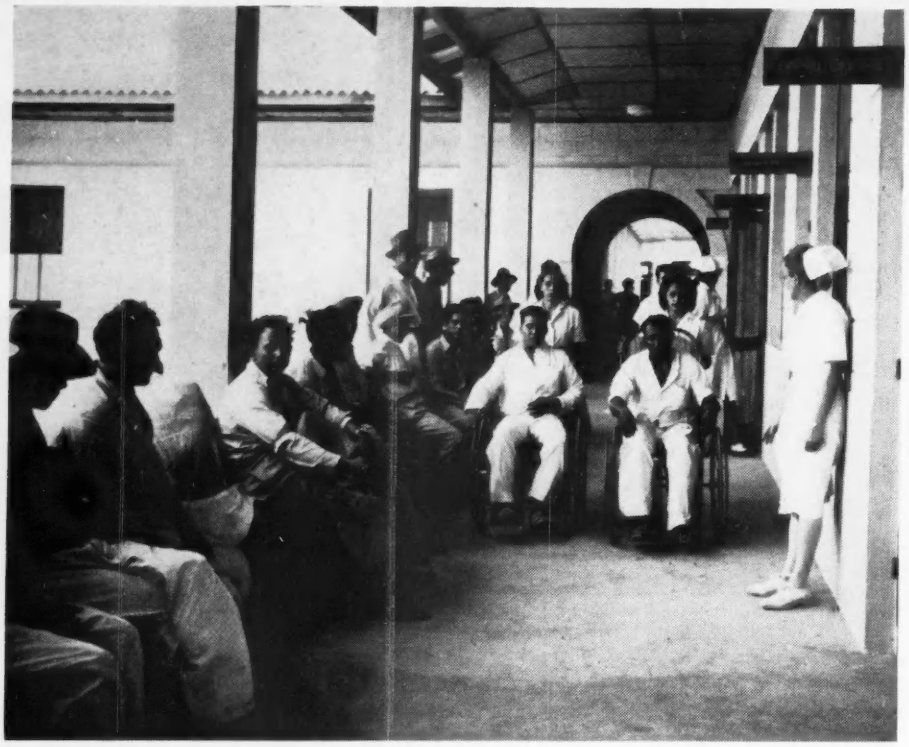
Informal discussions from time to time have revealed in a few instances what is to be looked for in the form of requests on various labor subjects. The present contract was to expire with the end of the year, and the companies were expecting to receive the petition of demands by December 1. From preliminary information available, it appears that labor will be difficult to deal with, and from the shape that some requests are to take, it is possible that the companies will be equally hard to deal with on certain specific matters.

One demand expected from workers is for a one-month paid vacation to all laborers, with provisions that the worker may elect to take only 15 days and be paid double time if he works the other 15. It is also rumored that labor will insist on a tripartite commission to pass on cases of discharge of employes. The commission would be made up in equal parts by representatives of labor, industry, and government.

It is likewise expected that there will be a demand for closed shop and for union hiring clauses.

Another probability was that the Federation may want to abandon the present procedure on grievances in favor of an arbitration committee required to make decisions in a matter of a few days. The system now in use channels cases through the company to the labor inspector, and then to the superior labor court, a procedure consuming three to four months between original question and decision.

Certain leaders of the communistic factions have recently indicated that their unions would not sign the contract under certain conditions. It is generally supposed that the government may take somewhat similar action in this event



This hospital was constructed when the first workers were moved in to construct a refinery at Paraguana. Photo by Ruth Robertson

to that taken 18 months ago at the time the present contract was drawn up. The dissenting unions were ordered to sign by governmental decree. It is to be assumed that the government is not likely to permit a strike in an industry in which it has such a big stake. Enormous public and social works programs have been budgeted which depend almost solely on income from petroleum. Whether or not the government would invoke all its powers to bring the two factions together is still a question, but it is understood that according to the law the petroleum industry is a public utility, and consequently the government has power to act to settle strikes. However, neither side is thought to be desirous of handling it in that manner if a strike were actually called.

Arbitrary Provisions

The new labor law, promulgated and effective during the early part of November, can lead to numerous disagreements, and in many cases seems quite arbitrary.

Perhaps the most far-reaching provision in the law is one dealing with placing employes of contractors under the same status as that which applies to employes of oil companies. Under Article 3 of the statute, workers employed by contractors working for oil companies shall be entitled to the same economic and social benefits due the employes of the company itself. The article is broad enough to include any service organization such as cementers, electrical logging companies, rigbuilders, etc., and could also go on to include anyone working for a company. It also could mean that they would be subject to the same hiring and firing clauses. It is taken to mean that workers for companies employed by petroleum firms on a contract basis can, as long as the contract is in effect, receive the same medical care for himself and his family as company workers. He also would be entitled to the schooling of his children, housing, or almost anything else being received by company employes.

In connection with hiring and firing clauses, the Superior Labor Court has held that the burden of proof is on the company in stipulating that discharge of any employe is not capricious. The court also held that the company is not required to actually re-employ men discharged under conditions held as capricious, but that it is subject to damages for breach of contract under the common law.

One new article in the law provides for the payment of unemployment benefits called "cesantia," based largely on a law in Costa Rica. An employe is entitled to it when:

(1) He is laid off for lack of work; (2) he is discharged without justifiable cause; (3) he resigns for justifiable cause; All as defined in the labor law.

The payments are based on period of employment in the following classifications:

After uninterrupted employment of not less than three months or more than six months he gets the equivalent of five days' pay.

For more than six months or less than one year he gets ten days' pay.

For more than one year, the equivalent of 15 days' salary should be paid for each year of work or fraction of a year greater than eight months.

The law also provides that he shall be entitled to payment even though he immediately becomes employed by another company or individual, but not if he is protected by an old age or retirement pension or by complusory unemployment insurance or is terminated by reason of death. If the other pension plan does not cover the full amount specified for cesantia, it must be made up by the company.

The controversial portion of this law is that it permits accumulation as far back as July 16, 1936. The big question is as to whether or not such a retroactive clause is constitutional.

It also is to be noted that this payment of cesantia is to be in addition to the present payment of "antiguedades" of two weeks' salary per year of service, so that the company ultimately is liable for a full month's salary for every year of service by workers. The present antiguedades rate is based on the wages earned during the **last** month of employment. Thus far the formula for payment of cesantia has not been specified. It may be construed as based on the last month of service preceding termination of employment, or it may be based on an average rate received throughout the term of employment.

Under the collective contract, certain concessions have been made in the payment of antiguedades by the companies. However, in the new contracts labor probably will insist on conditions at least as favorable for cesantia as for antiguedades.

Costly Feature

It has been variously estimated that, if the retroactive feature remains and is upheld by a test, it will cost the companies well over $20 million.

Actually, there are two theories as to the constitutionality of the retroactive feature. Those who take the position that it is constitutional argue that payment of cesantia is a penalty imposed upon the employer for possibly bringing about circumstances requiring termination of the employment contract against the will of the worker; and being a penalty, the period between his date of employment and July 16, 1947, whichever is the more recent, is a yardstick for calculating the amount of the penalty, and the right to payment accrues only at such time as the worker

is terminated for cause beyond his control on or after November 3, 1947, the effective date of the law.

Those who argue it is unconstitutional hold that it vests in the worker the right to receive this payment under contractional conditions which were not foreseen or agreed upon by the parties, and for which no reserve has been set up.

The new law specifies that workers shall receive 15 working days vacation for each year of uninterrupted service. This period already is being granted under the terms of the collective contract, although the old law stipulates only seven days In addition, the law provides that workers who do not complete a full year of service, shall be entitled to receive payment equivalent to one day's salary for each complete month of service. Two new national holidays have been specified, bringing the total to five, although many more holidays may be, and are decreed by national, state, or municipal authorities for which full pay is received.

Provisions dealing with hours of work are likely to cause confusion in the accounting systems, as well as in the planning of shifts.

Distinctions have been made between two different types of shifts. The first is an ordinary work day which may not exceed eight hours a day or 48 hours per week for labor, or eight hours per day and 44 hours per week for employes. The other is night work, seven hours per shift or 42 hours per week for labor or seven hours per day and 40 hours per week for employes.

An ordinary day work shift is defined as that in which work is performed between the hours of 5 a.m. and 7 p.m. Night work is that performed between the hours of 7 p.m. and 5 a.m. A **mixed** shift is composed of part daytime and part night time work, provided the time at night is not more than four hours. This shift cannot exceed 7½ hours per day or 45 hours per week. When the shift has a night period longer than four hours it shall be considered as a night shift.

Another article says that overtime shall be paid at the rate of a minimum of 25 percent over the salary agreed upon for the ordinary shift, and night work shall rate a 20 percent increase over the ordinary salary for day work.

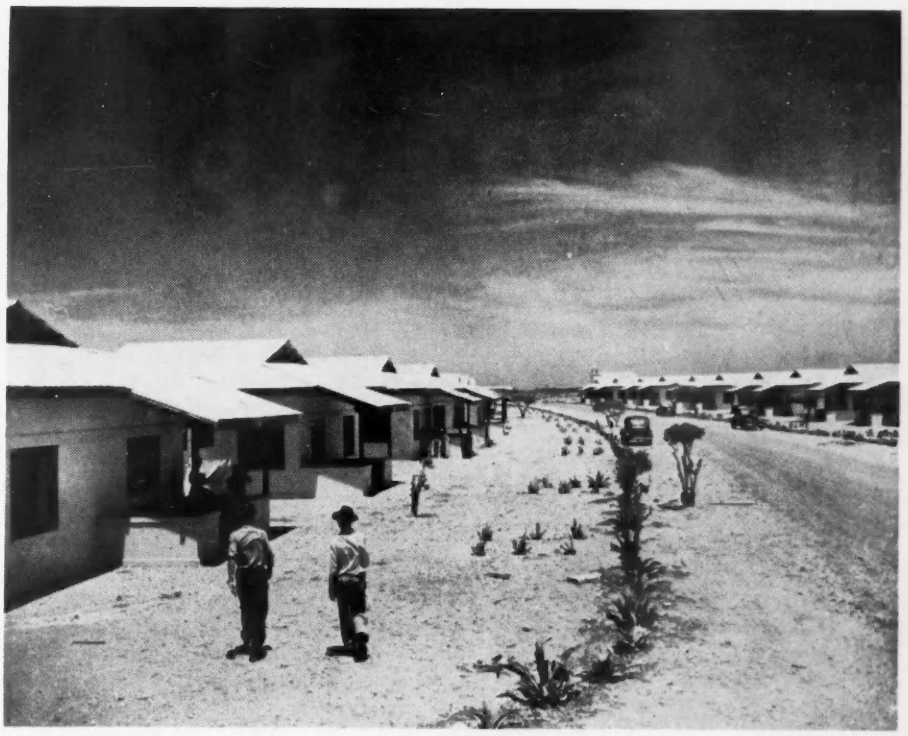
This offers possibilities of running more shifts at different hours than may ordinarily have been used by companies, but in any event it entails a day shift, a night shift, and a mixed shift, with the added possibility that a mixed shift might be construed as a night shift through having more than four night hours. There is also the question of whether employers must pay overtime in order to round out the 24-hour day on drilling operations on the basis of the normal eight-hour day or seven-hour night shifts, and whether night overtime will carry a rate of 25 percent over the normal or of 25 percent over the night bonus rate. And in cases of mixed shifts will the daytime hours be paid on daytime rates or at a rate specified as a night rate if more than four hours are worked at night?

The ministry of labor has taken the position that in a case such as a 12 midnight-to-8 a.m. shift, there being five hours before 5 a.m., it is a night shift and carries one hour of overtime with pay for the whole seven-hour night shift at night rates. It also takes the position that the hour of overtime must be figured on the basis of 25 percent over 120 percent of day rates.

The labor law also carries a provision making rest-day pay obligatory. Rest-day pay is the pay received for the seventh day in each week. In Venezuela when a worker puts in his full six days he gets paid for the seventh or rest-day. Under the terms of the collective contract, the industry had agreed to pay the rest-day if an employe did not miss more than four hours work a week. Under the new law he can miss a full day and still be paid for his rest day. He can work five days and get paid for six. As it now stands the company is not obligated to pay for days missed for sickness until an employe has been off due to illness for three days, after which his pay starts again up to 14 days, at which time he is credited with the first three. The industry is now, on its own initiative, paying time and a half for Sunday work when the worker's rest day falls on some other day of the week.

Toward the end of the statute are two articles regarding special protection of the state for properly organized syndicates. The first of these provides that any group of workers for a company, sufficient in number to constitute a syndicate, which shall formally notify the employer in writing, through appropriate labor inspectors, of its intention to form a labor syndicate, shall be under the special protection of the state. From the date of such notification, to the date of registration of the syndicate, for a period not to exceed three months, none of the workers shall be discharged, transferred, or reduced in position without justifiable cause previously so classified by the labor inspector. This provision is new, as previously it applied only to directors of syndicates.

Any discharge of workers in violation of the above is punishable by a fine. Disregard of an order of reemployment emanating from a competent official likewise subjects the violator to a fine when the discharge has been made without fulfilling the requirements specified.

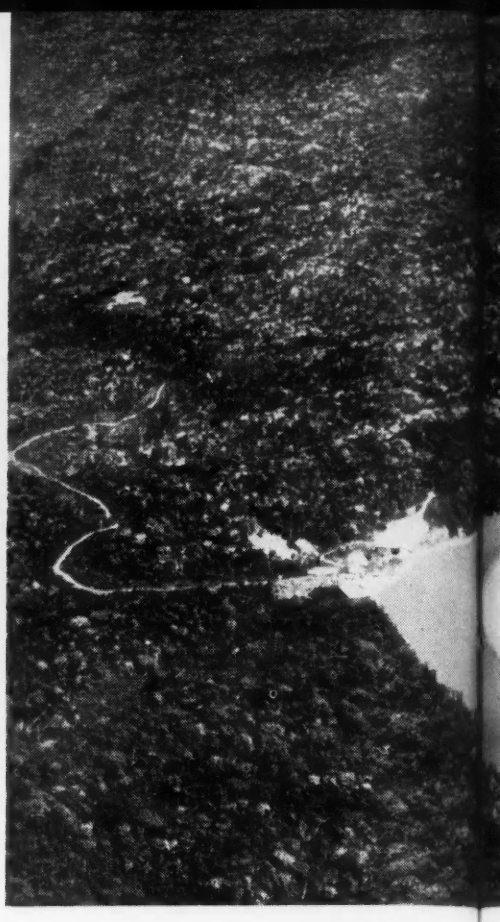


Portion of camp for housing workers at new Shell refinery being constructed on Paraguana Peninsula, Venezuela. The company furnishes homes with all conveniences and sanitation.
Photo by Ruth Robertson

By GEORGE O. IVES

Peru's Oil Program

HAMPERED BY POLITICS



WITH PRODUCTION declining, consumption rising, and exploration virtually at a standstill, Peru's political situation has prevented action on projects designed to accelerate the search for new reserves. Production is being maintained at the cost of depleted resources.

As THE year-end approached it became apparent that acceleration of oil activity in Peru would be postponed again, and the industry and the country itself would be right back in the situation of two years ago, aggravated by the fact that during the intervening time the nation had drawn upon its petroleum reserves without doing anything constructive toward expanding them.

With prospects last year of new petroleum legislation which would make more exploration territory available to foreign operators, many companies instituted preparatory programs of geological investigation. It now seems unlikely that anything will be done toward passing this legislation.

Actually, petroleum production has been maintained at a surprising rate in view of the age of the fields and the drain placed upon them by unprecedented world demand, and it was likely that the close of the year would see an increase in production over the 1946 figure, perhaps amounting to as much as 400,000 barrels. There also would be shown an increase in drilling activity and a definite increase in footage drilled in exploitation. But this increased drilling is expected to do little more than maintain the present producing rate of approximately 35,000 barrels daily. Meantime, none of the principal operators have acreage upon which to carry out the necessary extensive exploratory campaigns.

New Reserves Needed

It becomes increasingly apparent, through declining production in most fields throughout the past ten years, and the sharply increasing consumption of the past two years, that new reserves must be discovered if Peru is to maintain its favorable export-import balance and continue to reap the economic benefits accruing to any country exporting petroleum and its products in appreciable amounts. In previous years the balance has been quite favorable, but a projection of trends in production and consumption indicates that few years remain before it will consume all its production and become a net importer.

Observers are inclined to blame the political situation for lack of action. The necessity of legislative and other congressional action, and its importance to the future of the industry in Peru is not overlooked or minimized, but rivalry between the two principal political parties has been so spirited as to block action of any nature which might reflect to the credit of either. Since Congress went into session on July 28, and until shortly before the scheduled time of the session's end, there had not been a quorum at any session, and consequently no action on any question.

Of major importance was the proposed legislation to make it possible for both private and foreign capital to operate more freely with resultant expectancy of new reserves in hitherto unprospected or little-prospected regions. The new law was prepared through consultation with the firm of Hoover, Curtice, and Ruby, and embodied many of the features of the Venezuela petroleum law of 1943. It had been considered acceptable both to the nation and to private enterprise, but there seemed no possibility of its being acted upon in 1947.

Sechura Situation

Another important item of business scheduled for this congress was the ratification of a contract between International Petroleum Company and the Ministry for exploration rights to a huge tract just south of Talara and known as the Sechura Desert. The contract had been subject to congressional action, and the administration was highly in favor of seeing it settled. Earlier in the year approval seemed so certain that the bonus money, amounting to 29½ million soles (about $5½ million) had been written into the budget. Meanwhile, it was rumored that the company would no longer be interested if the contract was not ratified before its expiration date.

The Sechura Desert tract, comprising about 2,240,000 hectares, is desired by

Aerial view of Ganso Azul area, landing strip in foreground. Producing area of the field coincides with dark area within lighter outlines.

International more because of its proximity to present operations in the Talara fields than because of favorable knowledge of any particular structures. Since it directly adjoins the Talara properties on the south, it would be much more feasible to prospect than if it were located more remotely. Operations here would be most diffcult since it is actually a wasteland of sand, rock, and a few scrub bushes lying between the western slopes of the Andes and the Pacific Ocean.

In anticipation of the passage of new and favorable petrolem legislation, several foreign concerns instituted geological investigation involving considerable time and money, with Socony Vacuum Oil Company, the Shell Group, Standard Oil Company (N. J.) and Gulf Oil Corporation all maintaining some technical personnel in the country. However, in view of the current situation the staffs of all companies not actually holding property in Peru have been reduced and practically all work has ceased. Some of the personnel has been sent to stations in other countries, and only two of the outside companies still maintain offices with skeleton organizations in Lima. These are completing work of coordinating information already assembled in the form of geological data and geological investigation of aerial photography.

Together with the northern areas now held and operated by International, Lobitos Oilfields, Ltd., and Establecimientos Petroliferos Fiscales (government company) the Sechura Desert makes up the major portion of the prospective oil territory on the west, or more accessible, side of the Andes. The Montana region, a territory on the eastern side of the mountains in North and Northeastern Peru, comprises 125 to 150 million acres of favorable oil territory, and it is this region which is now holding the major share of interest.

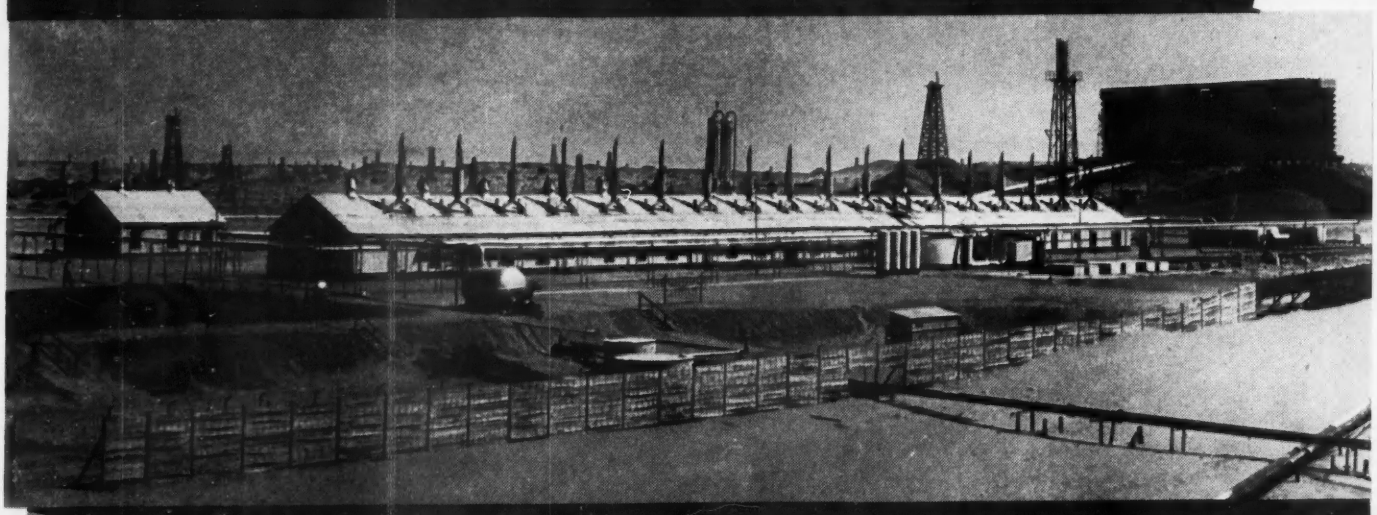
Production Established

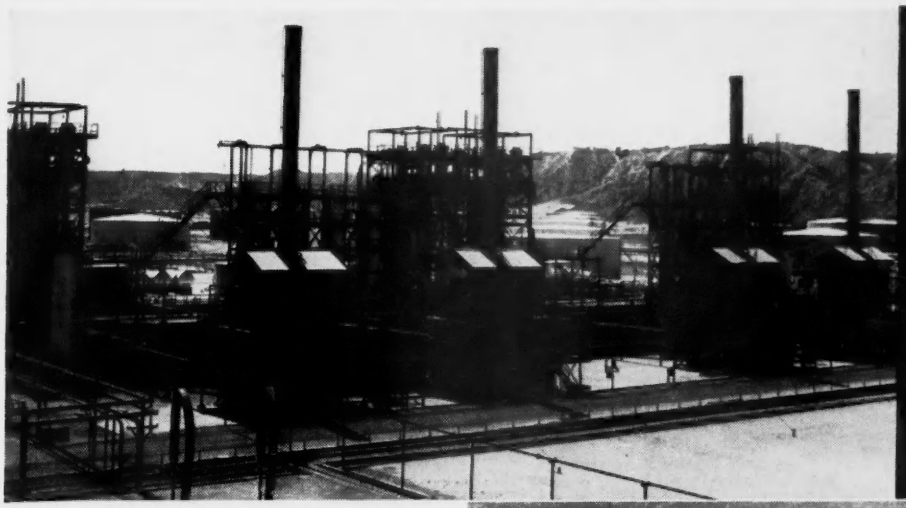
The existence of oil in the region has been definitely established through operation of the Compañia Ganso Azul on its 73,500-acre concession east of the mountains on the headwaters of the upper Amazon system, but the oil production established by this company merely serves to underline the difficulties of operation on the other side of the Andes. Discovered in 1939, the field now has six producing wells, and with completion of the latest producer in the middle of 1947 all drilling operations were halted. The field is estimated capable of producing more than 3000 barrels daily from its six wells, and yet is only able to produce 400 barrels daily because the bulk of the oil cannot be transported to any substantial demand center and the entire outlet consists of what products can be consumed in the local areas and delivered by water transportation. The field and a small, 600-barrel-a-day refinery are located near Agua Caliente, on the Ucayali River, one of the streams of the upper Amazon River system, and from there the products are moved by barge to a terminal now established at Iquitos, the principal town in Northeastern Peru, and about 700 miles by water from the refinery, employing a small fleet of tugs and barges for the difficult river route.

With Iquitos as the principal distributing point, further movements are made throughout the intricate river systems to points where products might be used. Total output was brought up to 400 barrels recently when the distribution system was extended down the Amazon River to the town of Manaos in Brazil. Average time for a barge load of products from Iquitos to Manaos is about ten days if water conditions are right, and 15 to 18 days return trip. About the same time is required from Agua Caliente to Iquitos. It is about 700 miles from Agua Caliente to Iquitos and another 1000 miles on down to Manaos.

Heavy equipment into Agua Caliente all came up from the Atlantic Coast of Brazil, up the Amazon and then up the feeder system. Time required for a single trip upstream is six to seven weeks.

It is thought that a line to carry oil across the mountains to the Pacific Coast would cost more than $30 million and would have to be supplied with 75,000 barrels of oil daily at a minimum. The lowest pass across the mountains from the general area is about 7500 feet high, and to reach this vicinity Ganso Azul would have to build several hun-





dred miles of line before starting the 500-mile trip across . . . all through difficult jungle and mountain terrain.

Meanwhile, two wildcats are being drilled in the Montana, on the Ucayali River about 125 miles north of Agua Caliente. One is being drilled by the government's E. P. F. on the west side of the river near Santa Clara, and another in the same vicinity on the east side of the river by Companie Peruana de Petroleo el Oriente, a firm formed by private Peruvian capital and using foreign technicians.

During 1946 Peru's total crude production amounted to 12,468,126 barrels, of which slightly more than 80 percent, or a little over 10 million barrels was produced by International Petroleum Company. Production trends for 1947 indicated that a slight increase would be recorded. During the first eight months of 1947 the nation produced 8,459,172 barrels, and late in the year production was at a rate which would justify an estimate of around 12,800,000 barrels total output by the end of December. This production has been maintained chiefly through the maintenance of output at the International Petroleum Company fields, but International's slight increases for the year are being offset for the most part by the decline in production at Lobitos to the north.

Table 1 gives the distribution of production for August, and for the first eight months of the year.

COMPANY (Producing Area)	August Prod.	First 8 Mo. 1947
International (Talara-Negritos)	870,309	6,782,966
Lobitos (Lobitos-El Alto)	195,707	1,528,607
E.P.F. (Zorritos, Copi)	1,209	8,748
E.P.F.	9,619	65,237
Ganso Azul	10,408	73,614
	1,087,247	8,459,172
Natural Gasoline:		
International	74,090	605,204
Lobitos Oil fields	8,633	75,269
	82,723	680,473

International Petroleum Company's production is from 2116 wells, of which 191 are flowing and 1925 on artificial lift. Following the initial postwar cutback from the rates believed to be excessive, it had built back to slightly more than 28,000 barrels daily by early last year and is now maintaining that rate by operating 16 rigs on its extensive properties.

The Lobitos company is producing about 6300 barrels daily from 875 producers, but is not now able to hold its production level through inability of the 13 cable tool rigs to drill enough hole to offset natural declines. The company recently installed a rotary rig, the first to be used on the concessions, and has another rotary that was being set up. The first well completed by rotary was drilled in about three months less than the normal time for a cable tool well, so the company's position should be bettered somewhat when both rotaries are working regularly.

The small production established by E.P.F. in all three of its Northern Peru areas from a total of 38 wells, and drilling activity consists of working three cable tool and one rotary rig in the Los Organos area of relatively shallow production. E.P.F. operates two additional rigs, both on exploratory work. One already has been mentioned as being in the Santa Clara area of the Montana region, and the other is in the old Pirin area on the shore of Lake Titicaca. This area once produced some oil, but the producer went to water, and the ten or twelve wells drilled since have all been failures. One rig is maintained in the area in an effort to reestablish production.

Gas conservation is practiced by both of the principal producing companies, with the system employed by International one of the most efficient in use anywhere.

Notwithstanding a producing area more than 50 years old, with some of the most complex faulting known, the company gathers almost every cubic foot of gas produced . . . from stripper as well as flowing wells. After processing for natural gasoline and other products, every cubic foot not used as necessary fuel is returned to the reservoir. Less than 1 percent of the total of 50 million cubic feet of gas produced daily goes into the air. Due to the nature of the ownership, with International holding the estate in fee, the company has bent every energy toward maximum ultimate recovery through preservation of reservoirs. The program was instituted more than 20 years ago and was in efficient operation long before such projects were in practice in the U. S.

Operators in Peru are plagued by essentially the same shortages which obtain everywhere, with the universal shortage of tubular goods the most vital problem.

Mining for Oil in JAPAN

THIS ARTICLE is a very slight condensation of a report prepared by G. B. Shea, a senior petroleum engineer, U. S. Bureau of Mines, while serving as scientific consultant in the Natural Resources Section, General Headquarters, Supreme Commander for the Allied Powers. The report, titled "Mining for Oil in Japan" is known as Natural Resources Section Report No. 89.

MINING fore petroleum by underground methods was undertaken in 1940 by the Japanese in the Higashiyama oil field as a means of obtaining additional oil from the sands unrecoverable by wells from the surface.

The mine workings comprise a system of drainage galleries and crosscuts dividing the oil sand into rectangular blocks of widely different sizes. The main haulage and ventilation galleries extend across the anticlinal structure from the bottom of two inclined shafts on the west flank of the structure. Drainage galleries extend along the strike of the structure from both sides of the main gallery. At the end of 1946 the total length of the galleries was 9252 meters. The oil is obtained by gravitational drainage through the mine openings and is transported through a gathering system, collected in a sump at the bottom of the main shaft and pumped to the surface.

Total production of crude for the first six years of operation of the Higashiyama mine was 24,914 kiloliters (156,710 barrels). Average production per meter of gallery for the period 1941-46 was 2.69 kiloliters, equivalent to five barrels per foot.

Operations were undertaken without careful studies of the residual oil content of the reservoir sands, or a correct understanding of the producing possibilities of the property. Recoveries leave much to be desired for profitable operation. The results achieved, however, appear to have been successful in view of limited natural oil resources and the great need for petroleum products. The work accomplished in pioneering oil-mining in Japan has provided a background of valuable knowledge and experience which will be beneficial in carrying out future mining projects.

Other shallow fields, such as Niitsu, Hibiki, and the Takeishi structure present possibilities of applying underground mining methods to recover additional oil.

Higashiyama Oil Field

The Higashiyama oil field is situated in the range of hills about eight kilometers (five miles) east of Nagaoka in Niigata Prefecture. The field is approximately 4.5 kilometers (2.8 miles) in length and 900 meters (0.56 mile) at its greatest width. The field is 700,000 tsubo (572 acres) in area and has three separate producing districts: Urase, Katsubo, and Katsurazawa.

Although several wells were dug by hand between 1873 and 1887, actual development dates from 1888, when oil was discovered at a depth of 120 meters (394 feet) in a well drilled by the Kazusa method of percussion drilling. In 1894 the introduction of the cable tool system of drilling gave impetus to the development of the field. An intensive drilling program was carried out which lasted until 1913, when the field was completely "drilled up." Company records show that 1228 wells have been drilled.

The oil-bearing sands occur in the Shiiya formation of Pliocene age. The structure is anticlinal with dips from 15 to 20 degrees on the west flank and 20 to 30 degrees on the east. The oil sands are cut by a number of minor faults on the west flank, which do not alter the general structural conditions.

The oil zone includes five sands that vary in thickness from five to ten meters. Sandy shale beds two to five meters thick separate the sands.

The Katsurazawa district in the most northerly part of the field is the site of current oil mining operations. It was discovered in 1895 and has a proved area of 67.24 hectares (166 acres). Within the defined limits of the field 254 wells including 15 dry holes have been drilled. Although the spacing on the surface is one well to 0.65 acres, all wells do not produce from each of the five sands and the average spacing in each sand is one well to three to four acres. The spacing, however, does not conform to a uniform pattern. Wells are from 200 to 320 meters deep.

All wells were completed as pumping wells with average initial production ranging from 0.32 to 3.18 kiloliters (two to 20 barrels)[1] per day. Of the original 254 wells, 160 (all on the flanks of the structure) were producing in December, 1946. Of the 173 wells drilled into the first, second, and third sands, now being drained in the mining operations, 118

TABLE 1
Yearly Oil Production from Mine and Wells, 1941-1946

YEAR	MINE			Wells* (Barrels)	Mines and Wells (Barrels)
	Boreholes (Barrels)	Galleries (Barrels)	Total (Barrels)		
1941	0.0	2,893.3	2,893.3	27,575.2	30,468.4
1942	0.0	22,651.7	22,651.7	24,435.7	47,987.4
1943	463.3	25,561.2	26,024.6	20,060.9	46,085.4
1944	2,968.9	30,860.3	33,829.2	22,637.0	56,461.2
1945	4,588.7	32,763.6	37,352.2	16,759.8	54,112.1
1946	6,790.1	27,169.7	33,959.7	12,474.0	46,433.7
Total	14,811.0	141,899.8	156,710.8	123,937.5	280,648.3

* Katsurazawa district.
Source—Imperial Oil Co.

were active producing wells at the end of 1946.

Peak production from all sands in the Katsurazawa district was reached in 1907. Since then output has declined steadily. At the beginning of mining operations in September 1940, the yearly output from this area had declined to 4,521.64 kiloliters (28,441.1 barrels). Daily production was approximately 13 kiloliters (82 barrels) or an average of 0.082 kiloliters (0.52 barrels) per well. The oil ranges in gravity throughout the district from 25.7 to 26.6 API.

Physical Characteristics and Oil Content

The three oil-bearing sands opened to drainage in the mine consist of poorly cemented medium to fine grained sands with many intercalated sandy shale streaks. Although compact in places, chunk samples of the sand may be broken by the fingers. According to the field records, the sands are ten meters thick and are separated by 1.5 meters of sandy shale. In the galleries visited in December, 1946, the exposed sands appeared to vary widely in oil content. Although parts appeared to contain substantial quantities of oil, large sections appeared to be almost depleted, with no evidence of drainage from the sand faces. As a result of the relatively low viscosity of the oil, the close spacing of wells and the long producing life of the field, it is probable that the more permeable parts of the sand were so completely drained by the wells that no more oil can drain by gravity through the mine openings. Furthermore, the irregular spacing of wells has resulted in some areas being more depleted than others. In driving the main gallery the perforated liner of a well was uncovered and is still in place near the face of the main gallery. The nearby sand is dry and appears to contain little oil.

Before starting mining operations a gallery test was made in 1939 to obtain information on the productivity of the upper, or first oil sand. For this test two vertical shafts 100 meters apart were sunk on the east flank of the structure and connected by a gallery driven through the sand at a depth of 100 meters. During a period of 115 days the 100-meter test gallery produced by gravity drainage only 7.93 kiloliters (50 barrels) of oil, or 0.5 barrels per lineal meter of gallery. Although this quantity of oil was far below that necessary for profitable petroleum mining, underground operations were undertaken without further testing.

To obtain an approximate measure of the oil content of the sands and to determine their porosities and permeabilities, eight samples of the exposed sands were taken at selected points in the galleries and sent, in sealed cans, to the San Francisco laboratory of the U. S. Bureau of Mines for analysis. The points at which the samples were taken are indicated by numbered circles on Figure 1.

The analyses show that the sands being drained through the mine openings are highly porous and highly permeable and that the permeability varies within wide limits.

The low oil saturation of some samples as well as the small percentage of the pore volume occupied by oil indicate that some of the sands have reached an advanced stage of depletion. The more permeable sands have been effectively drained.

The liquid pore space saturations (oil and water) of the samples are notably less and the chloride concentrations in the sands considerably lower than those usually found in similar sands in the U. S. The low concentrations of chloride suggest the possibility of an invasion of fresh water into the sands. It is noteworthy that a sample having a permeability of only 5.8 millidarcys had the highest chloride concentration. Thus it appears that any fresh water that may have invaded the sand did not flush the low permeability sections.

Production data were not available for

[1] 1 barrel equals 42 U. S. gallons.

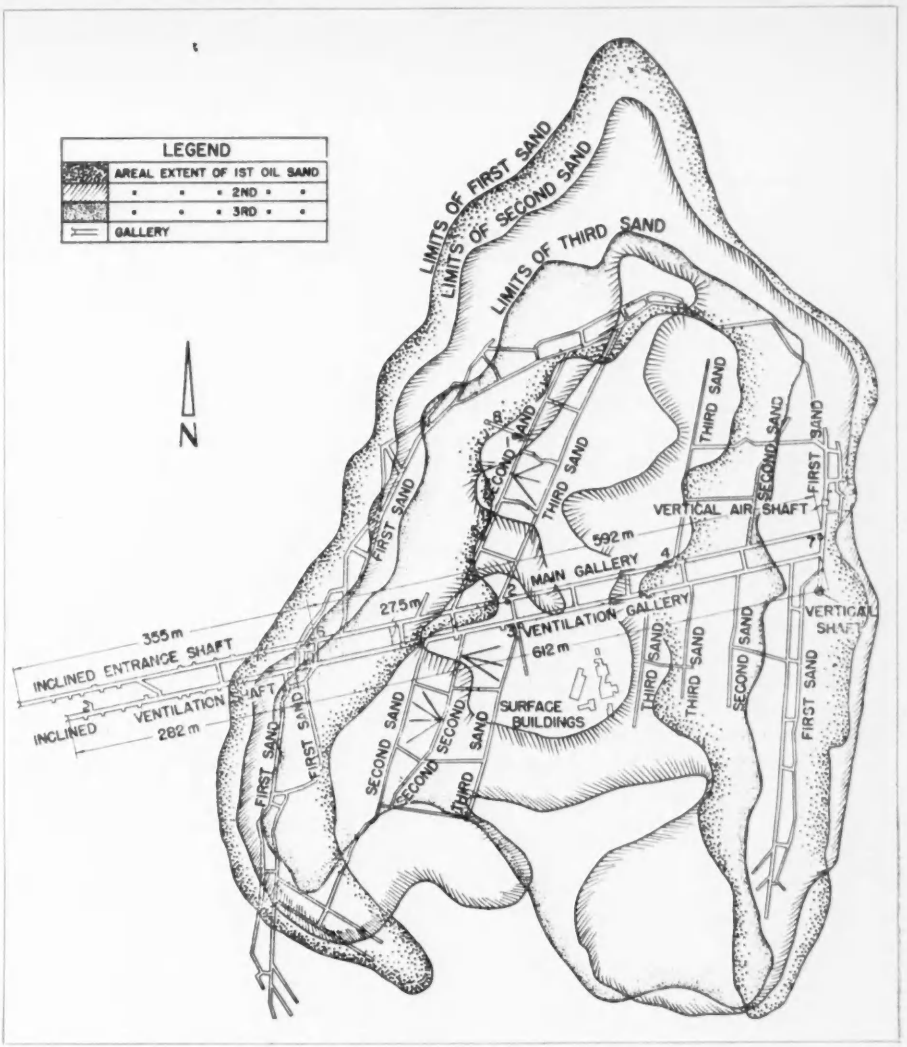


FIGURE 1. Map of Higashiyama mine workings, Higashiyama oil field, Niigata Prefecture.

TABLE 2
Mine Production and Advance of Galleries by Years, 1941-1946

YEAR	Production		Advance of Galleries		Production per Meter	
	Per Year (Barrels)	Cumulative (Barrels)	Per Year (Meters)	Cumulative (Meters)	Cumulative (Barrels)	Separate Years (Barrels)
1941	2,893.3	2,893.3	2,050	2,050	1.4	1.4
1942	22,651.7	25,545.0	2,750	4,800	5.3	8.2
1943	25,561.2	51,106.2	2,200	7,000	7.3	11.8
1944	30,860.3	81,966.5	1,870	8,870	9.6	18.1
1945	32,763.6	114,730.1	154	9,024	12.7	242.5
1946	27,169.7	141,899.8	228	9,252	15.3	148.9

Source—Imperial Oil Co.

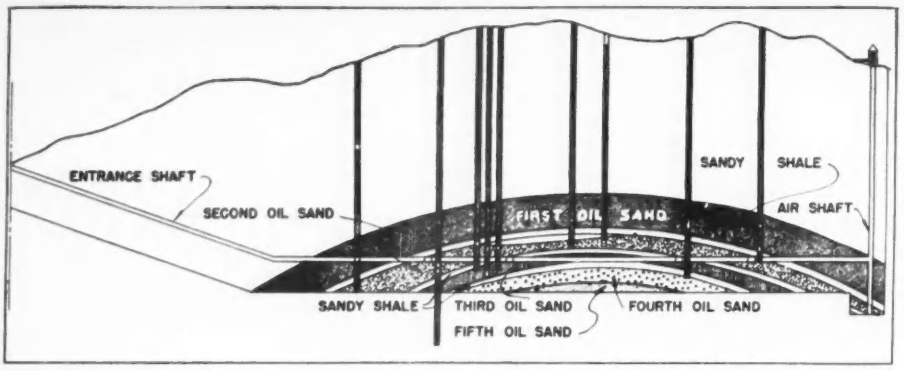


FIGURE 2. Diagrammatic cross-section of structure showing inclined entrance shaft and main gallery.

the three upper sands and recovery of oil by well operations is not known. Moreover, the absence of production data for these sands precluded the use of the production decline curve method to estimate the remaining oil reserve at the time mining operations were begun. It appears, however, that recoveries in the more permeable sections may be about 50 to 60 percent, most of which was recovered by well operations. The Japanese estimate a recoverable reserve of 390,000 kiloliters from mining in all areas of the Higashiyama field. This indicates a reserve of at least 115,000 kiloliters in the Katsurazawa area, now being mined.

Details of Mine Development

Beginning in September, 1940, two inclined shafts 27.5 meters apart were sunk to the first oil sand on the west flank of the structure. One is the main haulage shaft, which acts also for downdraft ventilation, and the other an upcast air shaft. The shafts were sunk at angles of 14° 5′ and 18° 30′ to inclined depths of 356 and 282 meters, respectively, where the first oil sand was reached in June, 1941. A horizontal main haulage gallery and a ventilation gallery were then driven at this same elevation transversely across the structure through the first, second, and third oil sands. The respective lengths of these galleries are 592 and 612 meters. Both are inclined slightly upward (1° 30′) from the bottom of the shafts to facilitate drainage of oil through gathering ditches. Figure 2 is a diagrammatic section through the structure showing the inclined shaft and the position of the main gallery with respect to the three oil sands.

Both the main gallery and the ventilation gallery are connected to one of the vertical shafts on the east flank of the structure, providing an additional upcast air shaft. From both sides of the main horizontal gallery, galleries have been driven into each of the sands approximately parallel to the strike of the structure. These galleries are inclined slightly upward (1° 30′) from the main galleries to aid draining and facilitate tramming excavated sand to the main haulage gallery. The mine workings are a system of galleries and connecting cross cuts that divide the oil sand into irregular rectangular blocks varying from 40 to 100 meters in length and from 15 to 100 meters in width. Figure 1 is a map of the mine workings as of December, 1946, when the total length of the entries, including shafts and horizontal galleries, was 10,100 meters. Of the total mine workings, the horizontal galleries had a total length of 9252 meters (30,532 feet)

Drainage pits 24x24x30 inches deep are sunk at alternate intervals of five feet on both sides of the gallery floors. The oil which drains from the sand collects in these pits. Once a day, or oftener if necessary, the oil is removed with one-gallon dippers and dumped into ditches in the center of the gallery floors, through which it flows to a collecting sump at the bottom of the main shaft. In December, 1946, the mine contained 299 drainage pits. Both the pits and the ditches have board covers.

Boreholes are drilled upward and fanwise into the oil sands at selected points in the galleries to obtain oil from the upper reaches of the sand that will not drain into the galleries. One to five holes, six centimeters in diameter and approximately 50 meters long, are drilled from each point. At the end of December, 1946, 102 boreholes had been drilled. The arrangement of the boreholes is shown in Figure 1. The holes are 20 to 40 meters apart at their extremities. Oil draining from boreholes flows into 100-liter wood drums, where it is gauged and then discharged through bottom outlets into the gathering ditches in the floors of the galleries.

Edgewater under a low hydrostatic head enters the mine on the east flank of the structure and aids the movement of oil through the ditches to the sump. Considerable surface water enters the shaft and also flows into the sump, where oil and water separate by gravity and are pumped to the surface.

Figure 3 is a typical cross section of a gallery showing the drainage pits and central ditch beneath the tracks. The galleries, measured inside the timbering, are 3 meters wide at the bottom, 2.4 meters at the top, and 2.2 meters in height. The ditch is .3 meters wide and .3 meters deep.

The method of timbering conforms to that used universally in drifting through relatively weak formations. Round unsawed timber, 18 centimeters (seven inches) in diameter, is used in the timber sets which consist of two legs, and cross-bar or collar (see Figure 3). The sets are spaced 1.2 meters apart and are

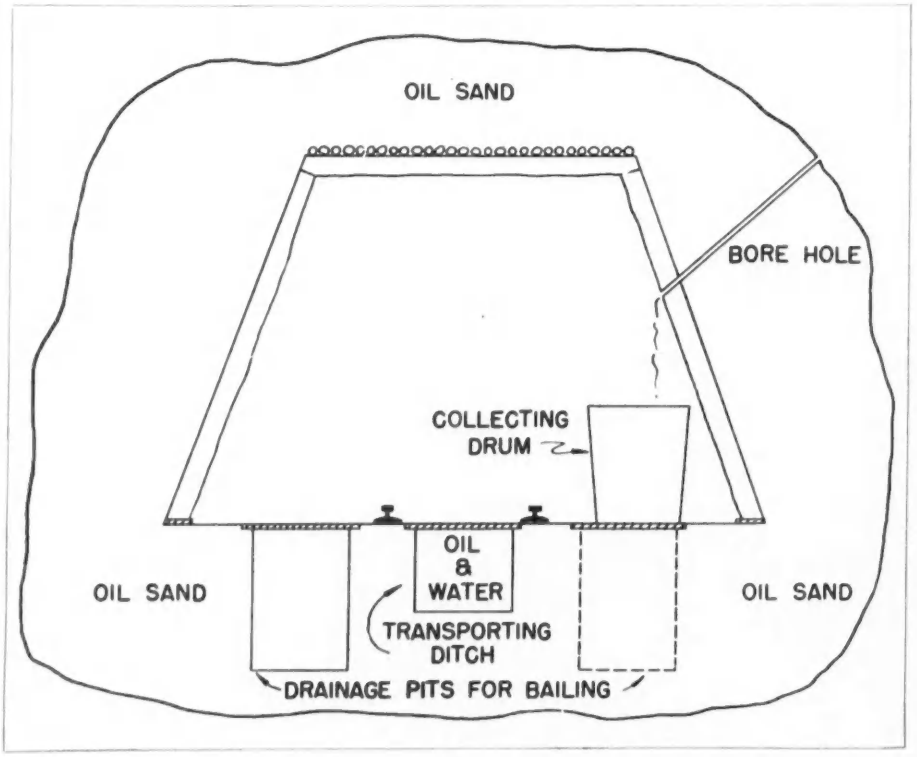


FIGURE 3. Diagrammatic cross-section of gallery.

lagged over the collars with round poles and sawed timber. Intermediate sets and extra lagging are sometimes placed to prevent caving.

Pneumatic picks are used to advance the gallery headings. In general the sand is readily sloughed off the face by the sharp pointed tool. Usually the miners first make cuts at each side and at the top of the face for placing the next timber set of posts and collar. When the timber set is in place and lagging inserted, miners cut away the middle body of the sand from the heading and repeat the procedure.

In driving entries or galleries, the excavated oil sand is hand-loaded into small steel dump cars of about ¼ metric ton (500-600 pounds) capacity. They are pushed by trammers to the main gallery, where they are hauled to the shaft and hoisted to the surface.

Exploitation boreholes are drilled into oil sand with a specially designed portable rotary drilling machine operated by compressed air at a pressure of five kilograms per square centimeter (70 pounds per square inch). At this pressure the bit rotates at 80-90 revolutions per minute. Fish-tail hard-faced bits six centimeters in diameter (2.36 inches), are used. Core-type bits are used only for sampling and drilling hard sands. Compressed air injected through the hollow rods removes cuttings from the edges of the bit and forces them out of the hole through the annulus between the wall of the hole and the drilling rods. Working three eight-hour shifts, three to five days are required to drill a borehole 50 meters (164 feet). No casing is used in the boreholes.

Collecting Sump

Oil and water flow into a collecting sump at the west end of the main galleries near the bottom of the shaft. The water and sediment settle out, permitting oil and water to be pumped separately to the surface. The capacity of the sump is about 3.2 kiloliters (20 barrels).

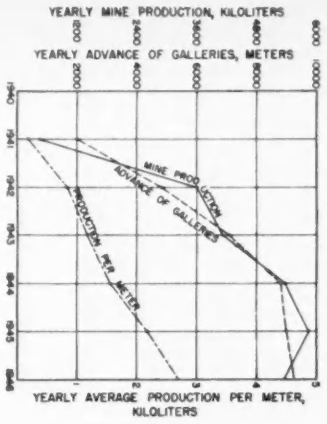


FIGURE 4. Relationship between yearly oil production and advance of galleries.

The water is pumped up the shaft to the surface in three 100-meter stages by electrically operated centrifugal pumps. The oil is pumped to a tank on the surface in one stage by reciprocating pump operated by an electric motor through reduction gears. The water and oil lines are 5½ and 4¾ inches in diameter, respectively. After an additional settling period in the surface tank the oil is pumped to Nagaoka for tank-car shipment to the refinery at Kashiwazaki.

The ventilation system is similar to that used generally in gassy coal mines. Fresh air is coursed through the galleries and crosscuts by fans near the surface between the main inclined shaft and the ventilating shaft and on the surface near the vertical ventilating shaft. The haulage shaft on the east flank of the structure is the main air intake and the fans draw the return air from the upcast ventilating shafts. The direction of the air currents through the galleries and crosscuts is controlled by doors placed at strategic points in the galleries and crosscuts. The two fans in the main inclined shaft have capacities of 18,000 and 45,000 cubic feet per minute, and that in the vertical shaft has a capacity of 18,000 cubic feet per minute. Owing to the long productive life of the field and close spacing of the surface wells, the sands have been virtually denuded of gas, and little diffuses into the workings from the gallery walls. No gas pockets have been tapped by the boreholes.

No gas odor was noticeable either in the headings or galleries during a visit to the mine. The absence of fires and explosions since the beginning of operations reflects the effectiveness of the ventilating system and other safety measures. Analyses of samples of the mine air taken in the various places throughout the mine showed that the hydrocarbon gas content (mostly methane) was not over 1 percent, and most samples were found to contain 0.5 percent gas or less, far below explosive limits. In December, 1946, the temperature in the galleries ranged between 5° and 7° C.

Underground workers use storage battery cap lamps only. Electric current from the surface is supplied only to the pumps at the bottom of the main shaft.

No explosives are used in the Higashiyama mine because the sand is easily broken by pneumatic picks.

The inclined haulage and ventilation shafts are lined with concrete to depths of 50 and 26 feet, respectively, and with square set timbering and lagging below. Both shafts are similar in section to the horizontal galleries. All hoisting of excavated sand and lowering of materials is through the main shaft. The upcast ventilation shaft is used only in an emergency. As a safety measure no workmen are lowered or hoisted through the shaft; they enter and leave the mine on foot.

Hoisting is by a small haulage engine operated by a 50-horsepower motor. Two electrically-operated air-compressors supply air to the drilling machines and supplemental ventilation at the headings. The surface equipment also includes forge, machine and carpenter shops for construction and repairs.

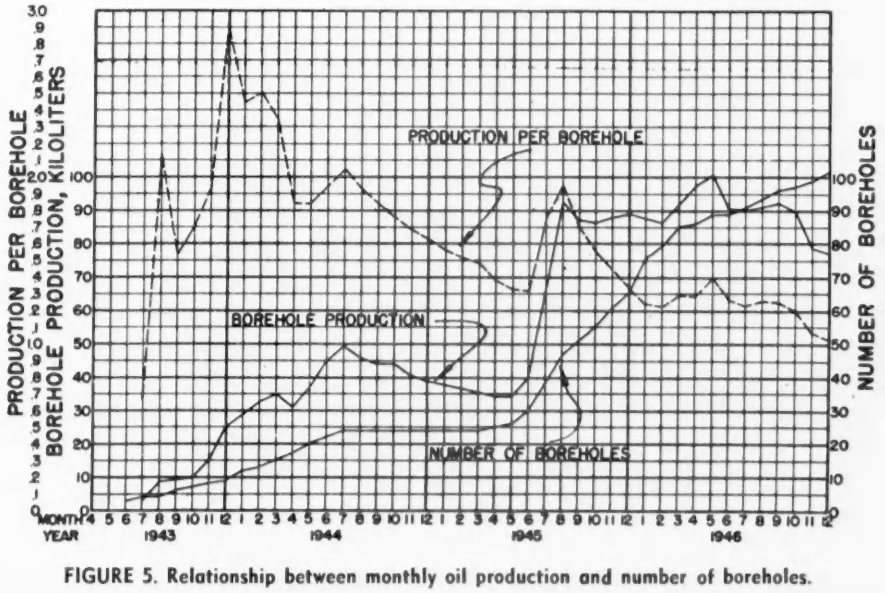


FIGURE 5. Relationship between monthly oil production and number of boreholes.

Mine Production from Mines

The annual production of crude oil from the Higashiyama mine for the first six years of its operation (1941-46 inclusive) is given in Table 1. During this period production increased steadily to a peak of 5938.66 kiloliters (37,354.2 barrels) in 1945, followed by a decline to 5399 kiloliters (33,959.7 barrels) in 1946.

The total mine production for the pe-

riod was 24,914.27 kiloliters (156,710.8 barrels). Of this total, 22,559.59 kiloliters (90.5 percent) were obtained from the drainage pits and gallery walls and 2354.68 kiloliters (9.5 percent) from the boreholes.

At the end of 1946 the daily oil production from the mine was 14.34 kiloliters (90.2 barrels). Of this total, 11.69 kiloliters (73.5 barrels) were from the pits and galleries and 2.65 kiloliters (16.7 barrels) from the boreholes.

During the first four years of mining operations, galleries were driven rapidly in an effort to increase production as much as possible to meet the increased wartime demand for petroleum. Following the completion of the inclined shafts in June, 1941, 2050 meters of galleries were driven in the remaining six months of the year. In 1942, the total advancement of galleries was 2750 meters, followed by advances of 2200 and 1870 meters in 1943 and 1944, respectively. However, only 154 meters were driven in 1945 and 228 meters in 1946. This sharp decrease in advancement of headins resulted from power and materials shortages and from the transfer of labor to shaft-sinking operations in the Urase district.

The relationship between yearly oil production and advance of galleries is given in Table 2 and shown graphically in Figure 4. The early rapid advancement of galleries is reflected in the uniform upward trend of mine production to the 1945 peak. As a result of the curtailment of driving of entries, however, a downtrend in production began in 1946, and the drainage of oil through the galleries and pits was 17 percent less than the 1945 output.

In order to offset the decline in gallery and pit production, borehole drilling was stepped up, resulting in an increase of 32.5 percent in borehole production for the year. Consequently, the overall decrease in mine production for 1946 was 539.36 kiloliters or 9.8 percent.

Included in Table 2 is the oil produced per lineal meter of gallery. The yearly increase in production per meter advance in galleries from 0.22 kiloliters (1.4 barrels) in 1941 to 38.56 kiloliters (242.5 barrels) in 1945 indicates that increasingly richer sands were opened to drainage. The highest drainage was reached in 1945 when the advance in galleries had decreased over 90 percent from the previous year.

The average yield per meter for the whole period of operation was 2.44 kiloliters, equivalent to 4.7 barrels per foot.

The drilling of boreholes upward into the oil sand was begun in June, 1943. At the end of 1946, 102 boreholes, comprising a total length of 4500-5000 meters had been drilled into the sand. Table 3 and Figure 5 show the number and monthly production of boreholes for the period from June, 1943, to December, 1946. Analysis of boreholes production shows that during the ten-month period from July, 1944, to April, 1945, only one borehole was drilled and monthly production declined from 44.22 to 34.70 kiloliters or 30 percent. As a result of the stepup in borehole drilling beginning in June, 1945, production was increased to a peak of 100.86 kiloliters in May, 1946. Despite the drilling of two boreholes per month for the remainder of the year, monthly borehole production declined to 77.85 kiloliters in December, a decrease of 23 percent from the May peak.

The productivity of individual boreholes varies greatly. In some areas, where the sands have not been depleted of their drainable oil, initial borehole productions up to 60 liters per day have been obtained. In others, where drainage by wells has been more complete, initial borehole production has been as low as a few liters per day. The average decline in borehole production is about 10 percent per month. Of the 102 completed boreholes at the end of December, 76 were producing slightly over a kiloliter of oil per month and 26 have ceased to produce.

The production of water from the mine amounts to approximately 95 kiloliters (600 barrels) per day, or about six times the oil production. Of this volume, 50 percent enters the mine from the surface and 50 percent results from ingress of edgewater. The amount of edgewater entering the mine is three times the quantity of oil produced.

Production from Wells

During the period 1941-46 the output from the wells decreased from 4383.97 kiloliters (25,575.2 barrels) in 1941 to 1983.14 kiloliters (12,474.0 barrels) in 1946, a decrease of 51.2 percent. Average daily production declined from 0.88 kiloliters (0.55 barrels) to 0.31 kiloliters (0.20 barrels). This sharp decrease in the output of wells that had reached settled production may be attributed largely to the depletion of the sand by drainage through mine openings.

According to the mine superintendent, 120 men were employed underground and 50 men on the surface. Those employed in pumping and maintaining the oil wells are not included as surface workers. In 1946, underground men received a monthly wage of 700 yen and surface workers 600 yen.

Both underground and surface workers are on an eight-hour shift and six-day week basis. The underground shift included the time from portal to portal, so that a man is at his working place from 6½ to seven hours per shift.

Assuming a production year of 300 days, the daily mine production for 1946 was 90 barrels, equal to 0.75 barrels per man-shift.

A study of yearly production, yearly advance of galleries, production of oil per meter, and oil-sand saturation leads to the conclusion that large sections of the sands were nearly depleted of their drainable oil by surface wells before beginning mining operations. This condition may be ascribed to a number of factors, including high permeabilities of the sands, relatively low viscosity of the oil, close spacing of wells, and continuance of well operations beyond the economic limit of production. It is probable also, in view of the initial well productions of two to 20 barrels per day, that the sands were not uniformly enriched

TABLE 3
Number and Productivity of Boreholes

YEAR	1943 Production (Kiloliters)			1944 Production (Kiloliters)			1945 Production (Kiloliters)			1946 Production (Kiloliters)			
	No. of Boreholes	Total	Per Borehole	No. of Boreholes	Total	Per Borehole	No. of Boreholes	Total	Per Borehole	Boreholes Drilled	Boreholes Producing	Total	Per Borehole
January	0	0.00	0.00	12	29.42	2.45	24	37.90	1.58	76	70	87.97	1.25
February	0	0.00	0.00	13	32.72	2.51	24	36.67	1.52	80	70	86.67	1.23
March	0	0.00	0.00	15	34.95	2.34	24	35.61	1.49	85	71	92.17	1.29
April	0	0.00	0.00	17	31.28	1.84	25	34.70	1.38	86	71	97.86	1.28
May	0	0.00	0.00	20	36.96	1.84	26	34.71	1.33	89	72	100.82	1.40
June	3	0.01	0.00	22	44.99	1.04	30	39.82	1.32	89	72	90.51	1.26
July	4	2.69	0.67	24	49.22	2.05	38	66.67	1.75	91	73	90.24	1.23
August	4	8.52	2.13	24	46.32	1.93	47	92.41	1.96	94	74	93.70	1.26
September	6	9.23	1.54	24	44.19	1.84	51	87.51	1.71	96	74	92.31	1.25
October	7	11.79	1.68	24	42.23	1.76	55	86.61	1.57	97	75	90.01	1.20
November	8	15.41	1.93	24	40.58	1.69	61	88.13	1.45	99	75	79.39	1.06
December	9	26.01	2.90	24	39.14	1.63	66	88.78	1.34	102	76	77.85	1.02
Total	9	73.66	8.18	24	472.00	19.67	66	729.52	11.05	102	76	1,079.50	14.73

Source—Imperial Oil Co.

and that in some areas the original oil saturations were low.

Comparison of the oil recoveries obtained during the initial years of development from the Higashiyama mine with those from Pechelbronn and Wietze mines shows a striking difference in the average yield per foot of gallery length. During the first years of operation the Pechelbronn and Wietze mines, drainage ranged from ten to 30 barrels per foot and eight to ten barrels per foot, respectively, compared with an average yield of two to three barrels per foot during the first three years of mining at Higashiyama. As a result of the sharp increase in productivity at Higashiyama in 1945 and 1946, the average production per meter for the first six-year period rose to 2.69 kiloliters (five barrels per foot). In the Pechelbronn mines the average yield per foot declined to five barrels after 12 years of operation.

Based on the cumulative oil production of 156,710 barrels from the mine and an estimated mine drainage area of 86.5 acres, the average recovery per acre has been approximately 1810 barrels. If the net sand thickness tapped by galleries and boreholes is assumed to be from 50 to 100 feet, the recovery by mine drainage as of December, 1946, was only 18 to 36 barrels per acre foot.

The cost of producing oil by mining methods depends largely on the quantity of oil per unit volume that remains in the sand and the ease of recovery by gravity drainage.

Table 4 is a statement on expenditure and returns from the oil mining project in the Katsurazawa area at Higashiyama. Development of the project involved a large capital outlay in the first three years of operations, mainly for shaft sinking, surface installations and engineering equipment. Development of mine workings began to show appreciable returns in 1942. However, the first profit on operating expenses, consisting mainly of driving new galleries and boreholes, was not made until the fiscal year of 1944, the fifth year of operations.

The loss in the fiscal year 1945 was due to the lag in increasing the price of crude oil, although labor and material costs increased greatly at the close of World War II. Despite a similar lag in price adjustment during the first half of the fiscal year 1946, a profit of 10 percent was realized during this period.

Because of the decreasing purchasing power of the yen during and following World War II, it is difficult to assess the amount required to pay off the original capital outlay in terms of present and future values of the yen. In June, 1946, however, total cost of production per kiloliter in the mine was 800 yen. At this time, the overall production cost in the petroleum industry was more than 1100 yen per kiloliter. A large return can therefore be expected from future operations, provided the production and operational efficiency is maintained. Assuming a recoverable reserve of at least 115,000 kiloliters from the Katsurazawa area and a future annual production of 6000 kiloliters, the mine has a production life of at least 19 years. Assuming a profit of 300 yen per kiloliter, an annual profit of 1,800,000 yen would be realized.

Converting the total expenditure in the same ratio as the increase in the price of crude oil to 1100 yen per kiloliter, capital expenditure is equivalent to 14 million yen and operating expenses to 41 million yen, a total of 55 million yen at current rates in June, 1946, for a turn on production of 30 million yen in the first 6¼ years of operation. Total deficit on the outlay to date is therefore 25 million yen at current rates in June, 1946. With an annual profit of 1,800,000 yen over additional capital outlay and operating expenses, it would take about 14 years to recover the losses accrued up to September, 1946.

TABLE 4
Consolidated Financial Statement

PERIOD (Fiscal Years)	Capital Expenditures	Expense	Production (Kiloliters)	Price of Crude (Yen per Kiloliter)	Income	Profit or Loss
July, 1940 March, 1941	715,526.25	371,556.60	98.94	100	9,894.00	361,662.60 (loss)
April, 1941 March, 1942	380,616.65	674,693.54	776.68	100 110*	79,609.70	595,083.84 (loss)
April, 1942 March, 1943	128,984.48	769,659.54	4,114.31	120	493,717.20	275,942.34 (loss)
April, 1943 March, 1944	72,737.11	905,911.78	4,453.29	139 175†	672,446.79	233,464.99 (loss)
April, 1944 March, 1945	22,585.98	751,490.56	5,242.20	175	917,385.00	165,894.44 (profit)
April, 1945 March, 1946	37,580.03	1,658,073.95	5,960.86	175 415‡	1,400,800.90	257,273.05 (loss)
April, 1946 September, 1946.	14,907.80	2,040,491.74	2,966.50	415 1105§	2,254,540.00	214,048.26 (profit)
Total	1,372,938.30	7,171,877.71	23,612.78	NA	5,828,393.59	1,343,484.12 (loss)

* Price increased to 110 yen, Jan., 1942. † Price increased to 175 yen, Dec., 1943. ‡ Price increased to 415 yen, Jan. 1946. § Price increased to 1,105 yen, July, 1946. NA Not Applicable. **Source—Imperial Oil Co.**

Production from this mine contributes about 2½ percent of the total annual production in Japan proper and is an important factor in the country's supply of crude oil. Continued development appears to be advisable. Unfortunately, the operation was undertaken at a very advanced stage of depletion and recoveries were therefore not as high as inticipated.

Other shallow fields in Japan present possibilities for the application of underground mining methods to recover additional oil.

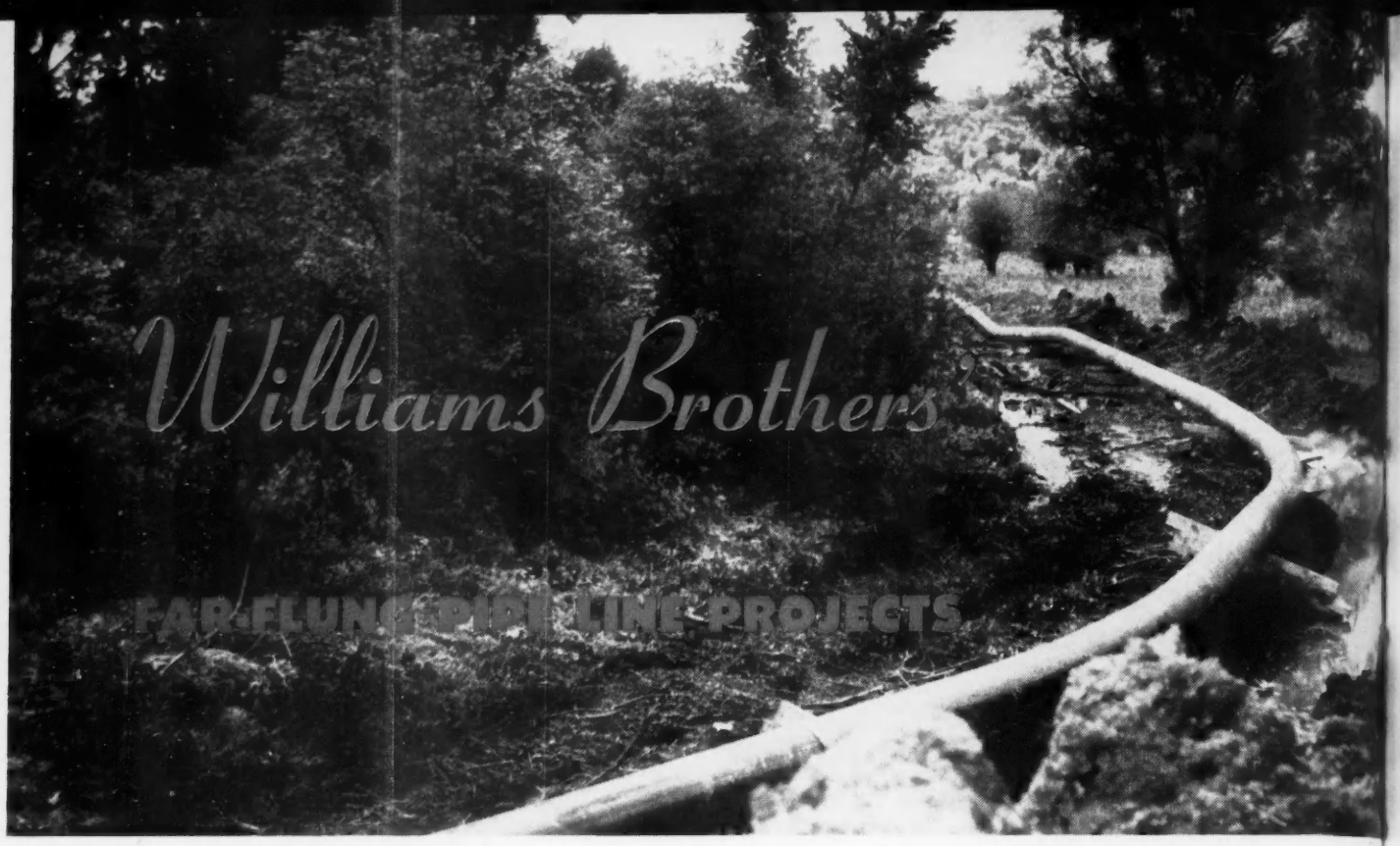
Shaft-sinking operations, aided by government subsidy, in the Urase district of the southern part of the Higashiyama field, have been in progress since 1944, in preparation for carrying out a development program. The plan of mine development provides for driving 15,696 meters of galleries and 1810 boreholes during the first ten years of operation. Engineers of the Imperial Oil Company estimate that the mine will produce 100,200 kiloliters (630,250 barrels). Of this total, it is estimated that 56,900 kiloliters (357,900 barrels) of oil will be recovered by drainage into the galleries and 43,300 kiloliters (254,350 barrels) from the boreholes.

These estimates were based on unit recoveries from the Katsurazawa galleries and boreholes. Although different sands will be opened to drainage in the Urase district from those being exploited at Katsurazawa, the history of development, subsurface conditions and density of drilling are comparable to the Katsurazawa district, and oil recoveries probably will be of the same order of magnitude.

The Koguchi district in the Niitsu field, Niigata Prefecture and the Hibiki field, Akita Prefecture, also are being considered for the application of underground mining methods.

The Takeishi structure, about eight miles southeast of Kashiwazaki, Niigata Prefecture has been considered for mining development. This undrilled structure is a prominent anticline with the Shiiya formation exposed on its crest.

Oil mining of carefully selected fields where conditions are favorable may profitably recover oil that is unobtainable by wells from the surface. Each field will require careful engineering studies, including analysis of production and subsurface data. Determination of porosity and oil and water content of sand samples are needed to estimate the quantity of oil remaining in the sand per unit volume and its drainability by gravity. Equally important is a knowledge of edgewater conditions, particularly the hydrostatic head and the amenability of the structure to mining operations. Where necessary, core-drilling tests should be made to obtain the desired information.



Section of crude oil line being laid by Williams Brothers for Creole Petroleum Corporation in Western Venezuela.

By ROBERT L. BUCK
Williams Brothers, Tulsa

A SPECIAL Overseas Division has been established by Williams Brothers at the Tulsa headquarters to expedite pipe line construction and contracting projects under way in Canada, Venezuela, Bolivia and the Middle East. In an unprecedented upsurge of activity which has steadily gained momentum since wartime, the firm is engaged in a number of important projects which are so located in the global time zones that it is unusual for the sun to set on a Williams Brothers crew.

OPERATING conditions for Williams Brothers crews range from "pretty soft" to "rugged." One of the current projects where conditions parallel the conveniences encountered in the U. S. is located in the vicinity of Montreal, Canada, where crews are laying a network of 12- and 16-inch crude and supply lines for Imperial Oil, Ltd. Work in this area is seasonal and must be completed to the best advantage of the project between the late spring thaws and early winter freezes. Good progress is reported on the project, which is expected to be terminated in early 1948.

Southward, Williams Brothers has a complete organization functioning in the Panama Canal Zone where the firm has laid all the principal Trans-Isthmian pipe lines and facilities necessary for the movement of crude oil and refined products for world commerce and the requirements of the naval and military establishments of the U. S. The company has established itself permanently in the Canal Zone as general contractors and is engaged in all types of construction work as well as presenting a service to outside interests for the purchase and expediting of equipment and materials available in the Zone.

The new Overseas Division is supervising work on two important projects in Venezuela and Bolivia.

In Venezuela, Williams Brothers has established a complete pipe line construction outfit at Maracaibo to build one of the largest oil pipe lines in the world. This line is for Creole Petroleum Corporation and extends from the Ule Station on the east shore of Lake Maracaibo in a northeasterly direction through the states of Zulia and Falcon, across the Gulf of Coro and the Paraguana Peninsula to Amuay Bay, where a large refinery is to be located. The line is to be approximately 144 miles long and is being constructed of pipe 26 inches in diameter. Also along the line will be constructed three of the largest pumping stations in the world, necessary to push this vast column of oil to its destination.

The line begins in a heavily timbered area that extends from the south end approximately 40 miles and then covers a portion of the country which is considered fairly good pipe line terrain. This extends into Creole's Dabajuro Station site, which is approximately half way. For the next 35 miles the country is very dry, comparing with terrain in West Texas and New Mexico. From this point to the Gulf of Coro it is more rolling, but cut up by deep ravines or "quebradas" and finally ends at the water's edge after crossing an expanse of drifting sand dunes.

From the south edge of the Gulf of Coro to the shore of the Paraguana Peninsula is approximately 15 miles and this portion of the job will be laid as any major river crossing. It will be laid on the bottom of the Gulf so that the severe currents and tides will not disturb its location. Weather conditions on on this last portion of line are very severe as there are strong winds that blow daily, so that construction work will be accomplished under extremely difficult conditions.

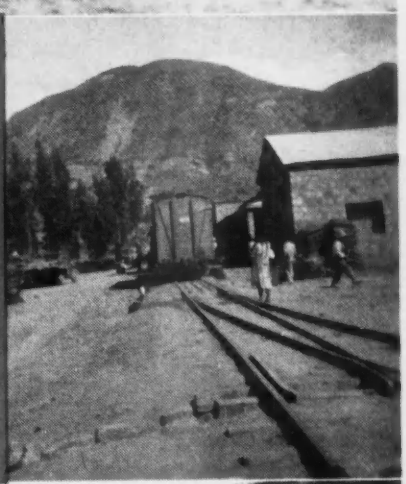
On the east coast of Venezuela at Puerto La Cruz and Barcelona, Williams Brothers originally located in October, 1945, for the construction of

VIEWS OF *Bolivian* PROJECT

BELOW: Camiri-Sucre Road, Lamboyo Canyon.

ABOVE: Along Camiri-Tin Tin right-of-way.

RIGHT: End of Cochabamba-Tin Tin line.



BELOW: Pump Station No. 1, Camiri, showing garage, chief operator's residence and 10,000-barrel tank.

ABOVE: Road crossing the River Grande.

LEFT: The line goes over this near Zudanes.

RIGHT: The going gets rough near Rio Acero.

Equipment has to be good to stand the gaff of desert conditions. Williams Brothers trailer-truck plows over the waste land with ten joints of 30-inch diameter pipe, each joint being 60 feet long. Pipe and hauling equipment represent a gross load of 104,000 pounds.

approximately 400 miles of access roads to the new oil field in the vicinity of El Sombrero and Chaguaramas. The road construction has since been completed, and the firm is now engaged in the construction of several bridges, large tank farms, breakwaters in the harbor, and has recently completed approximately 77 miles of 12-inch oil line for Socony-Vacuum Oil Company. The firm is now preparing to lay 140 miles of 16-inch crude line for The Texas Company and work is due to begin with arrival of pipe and materials, expected early in 1948 or at the end of the present rainy season. Permanent shops and warehouses have been established at Barcelona and all negotiations for work in this section are conducted through the offices at that place. At the present time approximately 125 Americans and some 500 nationals are employed.

Bolivia Project

One of the firms most difficult projects is located in Bolivia with headquarters at Sucre and is designed to establish a transmission system for crude produced in the vicinity of Camiri and destined for projected refineries at Sucre and Cochabamba. The contract was let by Yacimientos Petroliferas Fiscales Bolivianos, the Bolivian government oil monopoly.

Engineers first were transferred to the job site in the spring of 1946 and during the time that rights-of-way were selected and surveying begun, equipment, material and personnel were being assembled in the U. S. and shipped to Bolivia so that actual construction got under way during the summer of 1946.

Williams Brothers engineers agree the Bolivian project can well be classified as a "rugged" operation. The original project called for the laying of approximately 261 miles of six-inch all-weld pipe and three major pumping stations. The project now has been expanded to include an extension from a point near Zudanez to Sucre and from Tin-Tin, its original terminal, into Cochabamba.

Transportation poses the greatest problem, since it is necessary that all equipment and materials be transferred by boat to Antofagasta, Chile, and then transhipped by rail over the long and hazardous route to the railhead at Villa Villa. From that point everything is transported over roads that had to be built as a part of the project.

In early 1947 when materials for the project were being delivered to various ports in the U. S. the problem arose as to the possible difficulties to be encountered in transporting heavy equipment and long pipe joints from South American coastal ports inland over possibly inadequate rail facilities. Large engines and pumps for the station represented in themselves more tonnage than rail cars could handle and, therefore, had to be assembled in a special manner to facilitate movement from ports to destination points. The pipe was shipped in lengths of from 46 to 51 feet and at one time it was considered that it would be necessary to cut these lengths at the port due to the fact that available cars were only 25 feet in length. However, after a careful study of curves and grades, it was found that the pipe could be hauled by placing one empty flat car between two loaded ones. The movement of the pipe by rail proved to be much easier and simpler than the subsequent movement by truck from the railhead to the right-of-way. Due to steep grades and extremely short turns in the only available roads it was necessary to improvise a trailer. This was accomplished by rigging all stringing trucks and trailers in much the same manner as logging sleds.

The route of the pipe line begins at Camiri at an elevation of 2400 feet and extends to Tin-Tin, which has an elevation of 9500. The extension to Cochabamba will attain an elevation of 8400 feet and the branch lines from Zudanez will be 9700 feet above sea level at the Sucre terminal. Two additional pump stations are planned to move crude to the proposed refineries at Sucre and Cochabamba and the lines will traverse rugged country that reaches an elevation of 11,000 feet above sea level.

The pipe line itself will be laid atop ground for its entire length with the exception of a few road crossings. River crossings will be laid either on the bed of the river or supported by cable spans. The entire line will be covered with a cold corrosion preventive.

Additional personnel for the construction of the pump stations were sent to Bolivia in August and work is now under way at the station sites. Locations have been cleared and tank bottoms and fire walls completed and preparations made for the concrete work and construction of the station buildings. All stations will be constructed from cement blocks manufactured on the job site. Pipe has now arrived in sufficient amounts for stringing operations and the actual laying of the line is in progress at Camiri.

In the Middle East, preliminary work began in May on approximately 450 miles of 30- and 31-inch crude line for Arabian-American Oil Company. It will traverse portions of Lebanon, Syria, Trans-Jordan and Saudi Arabia. Since the inception of this project, plans have been made and changed, equipment purchased and modified to suit conditions, and personnel has been transferred from the U. S. to the present location at Beirut in Lebanon. If progress continues at the present rate all equipment, materials and personnel will be at the job site early in 1948 and ready for actual pipelaying operations upon the arrival of the pipe in March.

Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

OUR 28th YEAR

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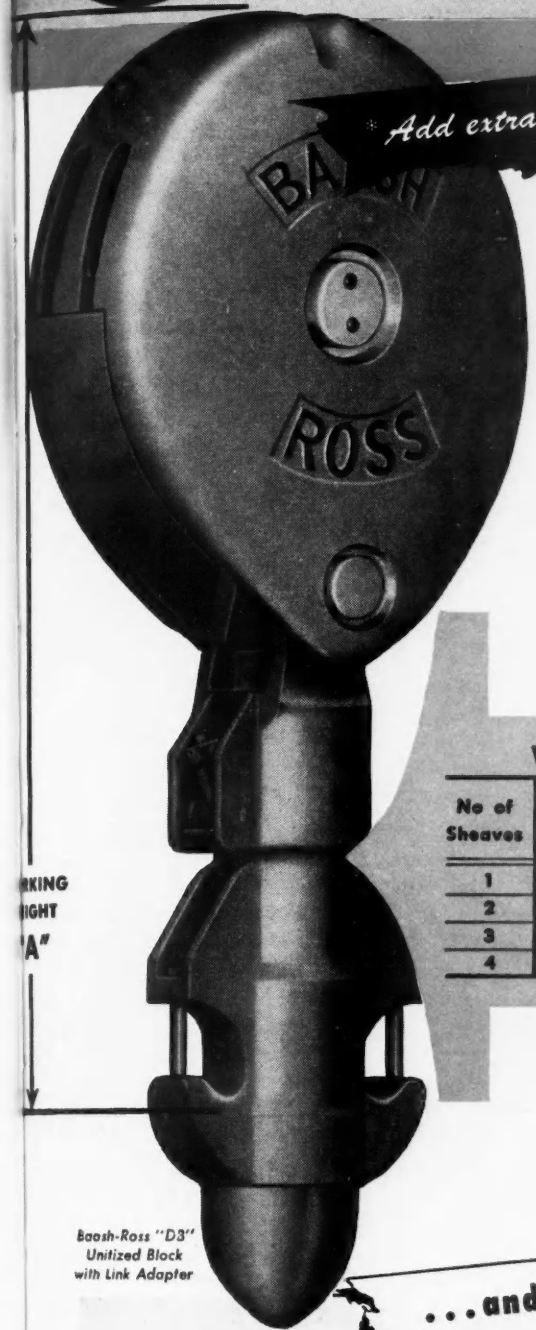

Baash-Ross "D3" Unitized Block with Link Adapter

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ON SPACE SAVINGS ALONE Baash-Ross Unitized Blocks represent a far-reaching advancement in portable rig equipment. For these Blocks combine in ONE rugged, compact unit *both* the traveling block and the hook or connector for supporting the drill string.

WORKING HEIGHT "A"

No of Sheaves	SHEAVE DIAMETERS			
	20"	24"	30"	36"
1	50"	54"	60"	—
2	58"	62"	68"	—
3	63"	67"	73"	—
4	—	—	76"	82"

In the table at left are shown overall measurements for typical sizes of Baash-Ross Unitized Blocks. *Compare these dimensions with any other block and hook arrangement of comparable capacity.* Only then will you see how important are the space savings made by Baash-Ross Unitized Blocks—savings that actually add *extra feet* to the working height of your portable rigs. By adding more working room to your portable derricks, many vital savings are made...

FASTER TRIPS Risk of hitting crown is reduced, permitting faster operations, quicker round trips, more time on bottom.

GREATER SAFETY Increased working space means greater safety for both crew and equipment, fewer accidents, lower drilling costs.

LONGER PIPE Often the space saving of Unitized Blocks permit using longer pipe lengths, further speeding operations, saving time.

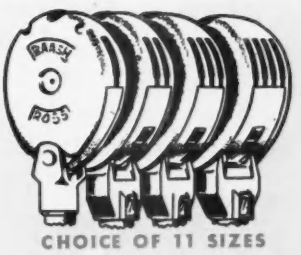
...and these advantages, too!

SIMPLER HOOK-UP

By eliminating extra elements in the hook-up, Baash-Ross Unitized Blocks are not only more compact, but also more streamlined than other arrangements. Nothing to catch in girts or rigging means still greater safety to crew and equipment, faster round trips and peak operating efficiency at all times.

CHOICE of TWO TYPES

Baash-Ross DB Unitized Blocks are available in two basic types—either with Hook (left) or with Link Adapter Unit (large illustration). Both styles are free-swiveling . . . or can be instantly locked in any one of 8 different positions. Also, both are spring loaded. Link Adapter unit is recommended for maximum capacity and simplicity.



CHOICE OF 11 SIZES

Not only are there two basic types of DB Blocks, but each type is available in choice of 1, 2 or 3 sheave models with capacities of 30, 65 and 100 tons, respectively, and each in choice of 20", 24" or 30" sheave diameters . . . or in a 4 sheave model with 150 ton capacity and choice of 30" or 36" diameter sheaves. There's a size for every job—one for *your particular* requirements!

For more information see your nearby Baash-Ross representative. Or write direct.

As protection against falling objects and slipping on oily derrick floors, workers on Imperial Oil rigs are required to wear steel helmets and safety shoes.
Photo Courtesy Imperial Oil, Ltd.

Imperial's Safety Record Is NO Accident

DESPITE a popular misconception, oil fields and oil refineries are not places where the workers spend their days threatened by violent accidents.

Fires in oil fields, refineries or tankers at sea are usually spectacular and are apt to make the headlines. So it is quite natural that the public should believe that the petroleum industry is a peculiarly dangerous form of employment. In actual fact, the number of fires and accidents in the oil business is remarkably low in comparison with other industries.

This doesn't just happen. It has come about as the result of careful study, and an intensive program of education. Today the oil industry could be taken as a pattern for the every day application of simple precautions and good sense.

Careful planning and constant emphasis on common-sense precautions have established an enviable safety record in the Canadian oil industry. This is particularly true in connection with Imperial Oil Ltd., Canada's largest operating company.

Imperial Oil has given constant and intensive study to the causes and prevention of fire and accidents. Practical results of these efforts have been most satisfactory.

The company conducts a continuous campaign of safety education among its employes to prevent anything from a major disaster to a minor personal injury. The company investigates the basic causes of all accidents and takes all possible steps to prevent their recurrence. Information gained in this way is distributed to personnel in a monthly accident bulletin.

General surveys show that mechanical defects cause only seven or, at most, 10 percent of all accidents. Physiological causes—such things as inadequate lighting, improper ventilation and bad housekeeping, account for 20 to 25 percent of the mishaps.

Giving these causes, mechanical and physiological, their fullest value, 65 percent of all accidents remain. These have been found to have psychological causes. Workmen who are unsuited to their particular employment, who are unhappy in their personal lives or maladjusted to their fellow workers; and those who are negligent, reckless or inclined to disregard an order—these are the people involved in the majority of accidents.

While it is beyond the power of any company to see that all its workers are perfectly happy, Imperial strives continually to maintain the best possible working conditions, and the high morale among its employes acts as an accident preventive.

Industry has a definite stake in accidents that happen to its workers in their homes. U. S. statistics for a single year show that 33,500 persons died in accidents in the home compared with 16,000 involved in occupational accidents. Between 1928 and 1945 fatal accidents in the home showed an increase of 12 percent while industrial accidents for the same period declined by 16 percent. Similar conditions prevailed in Canada.

It is significant that few accidents befall Imperial personnel in their homes —proof that the company's policy of safety education is all-effective.

Personnel joining Imperial are given a physical examination and care is taken not to place any person in employment for which he is not physically capable, both as a protection to the individual himself and to his fellow workers.

In addition to the informative monthly accident report, and other circulars, Imperial Oil provides safety instruction courses. Thsee teach the worker accident hazards that exist in any particular job and how he should offset them.

Posters keep personnel acquainted with both common and unusual accident hazards likely to exist in their work. They deal with the particular, avoid general statements, and give terse, constructive information on such things as right and wrong methods of lifting a heavy weight or unloading a barrel from a truck.

Fire is the most obvious hazard in the petroleum industry. In handling inflammable products the danger from fire occurs when they come in contact with the air. The threat of fire is negligible if maintenance is in first class condition to prevent spills or leaks. Rigid inspection is maintained and the company stresses fire prevention measures as the essence of fire protection. Educational

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films on fire prevention are shown periodically to plant personnel.

Above-Ground Tanks

As one illustration of results in the past 20 years the company has operated an estimated annual average of 3500 above-ground gasoline storage tanks under control of the marketing department. The number of breakages in tanks or pipe line equipment does not exceed 1/200th of 1 percent per year of the total tanks installed.

On each occasion where breaks did occur the leakage was observed shortly after the break took place and the damage was confined to the loss of liquid and repair to the valves. No fires resulted.

The company maintains, wherever needed, portable hand fire extinguishers, fire trucks to fight large fires and permanent plant installations operated by remote control valves to dispense fire-killing liquids such as foam, carbon dioxide, steam or water. Constant fire drills keep workers fire-conscious and reveal fire hazards. Fire prevention is built into units and fire walls guard tanks.

Fire at sea is an ancient horror and one against which every possible precaution is taken on Imperial's fleet of tankers. Steamships are equipped with steam-smothering devices through which steam is piped to all oil tanks and can be released by the opening of a valve. Diesel-powered ships are equipped with what is known as the "Lux" system. This consists of highly compressed carbon dioxide gas in batteries of steel flasks from which a remote control lever releases the gas. They also have foam systems of various types which act like a bubble bath and smother fire by shutting off the oxygen. All ships are equipped with hand extinguishers as well.

Great care is exercised during the loading and unloading of petroleum cargoes. A tanker cargo may be as much as 135,000 barrels or 4,725,000 gallons of gasoline, and the importance of these safeguards cannot be overestimated. Before loading and unloading operations are begun, ground wires are run ashore to drain off static electricity from the ship and dissipate it harmlessly. This is a precaution against a spark occurring at the end of the discharge hose when it is being connected. During electrical storms all loading and unloading stops.

In the handling of highly volatile products such as casinghead gasoline, the loading is conducted in a closed circuit and the gas taken ashore to be exhausted safely. In this operation the gas is pumped directly from the cargo tank and led through pipes to a safe area—often as much as a quarter mile from the dock—where it is dissipated in the presence of steam. The steam is an additional safeguard against fire.

On ships that transport petroleum products, open electrical switches or open light bulbs are prohibited. Electric light globes are protected by water-and-gas-tight coverings.

Fresh air masks of various types are used for men working in tanks which may or may not be free of gas. Gas detectors called explosion meters are used to test tanks before men enter them. This apparatus inhales gas from the tanks and draws it over a filament which gives an acurate reading of the gas content. When a tank is described as "safe for man and fire," it is known to be completely gas free and there is no danger from operations such as use of a welding torch. If work is to be continued for days, tests are conducted frequently.

For cleaning tanks in ships that carry petroleum products, Imperial employs "the Butterworth cleaning system." An apparatus is used that looks something like an outsized garden sprinkler operating on two axes, vertical as well as circular. It washes out the tank with very hot water, eliminating the hard, manual work of tank cleaning and making it unnecessary for men to enter tanks which might contain gas.

Precautions similar to those used by the marine department are taken in loading and unloading railway tank cars and trucks. Ground wires are attached to the rails to drain off static electricity that might be a fire threat. The same principle is behind the chain that "grounds" automotive vehicles carrying petroleum products.

Working conveniences in oil fields present a sharp contrast with operations 20 years ago. Many are the result of constant attention and improvement in the design of drilling equipment from recommendations made by the company's accident prevention committees in each area.

Unusual speeds have often been associated with drilling operations because of competition between crews drilling neighboring wells anxious to reach pay sands first. Such rivarly sometimes created unsafe speeds. Today's drillers understand the difference between safe and unsafe speeds and work is carried on only at a rate consistent with safety. Members of all drilling crews are required to wear helmets as a protection against the possibility of tools being dropped or bolts and nuts falling from the derrick structure.

In refineries, safety precautions begin at the gate where all who enter are required to surrender matches. Often a gas jet is kept burning outside the gate for those who wish to light up immediately on leaving. Smoking is permitted within the refinery precincts only in areas designated as safe. This is a precaution against sparks or flash where gas or inflammable vapors may have accumulated.

Color plays an important part in the prevention of accidents. The safety department has a high appreciation of the value of interior painting of walls to provide adequate light. Light or bright-colored paint draws the attention of machine operators to fast-moving parts which might cause accidents.

It is in the interest of safety that each worker be properly dressed for his work. Goggles and face masks are provided by the company where there is danger to the eyes of workers. Equipment such as heavy gloves, safety shoes with non-skid soles and steel toe caps is encouraged.

Many other devices are in use in Imperial's plants for the protection of workers. Telephone pole guy wires have shields and are indicated by striped painting. Guards on rising steam valves prevent head bumps. Safety ladders have hoops and non-skid feet are used. Gas detector apparatus like that employed on tank ships is used before hot work is permitted.

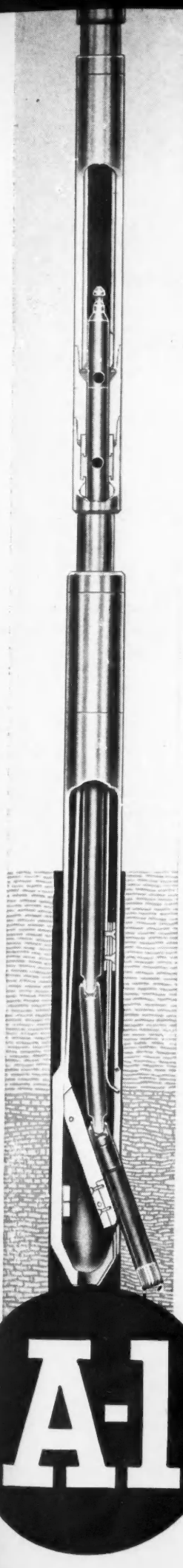
Buildings, tanks, towers and processing units are equipped with emergency exits. There are safety valves on equipment and blowdown devices for emergency shutdowns. All equipment is frequently inspected for corrosion and wear. Alarms indicate the presence of combustible or dangerous gas. Walkways and treads are non-skid. Pressure vessels in processing units adhere to safety standards. Floodlights add safety to night operations.

Where acid or lye is used, emergency showers are ready for cases of accidental spraying. All workers are taught that if a person accidentally gets chemicals in his eyes he should wash them out immediately with great quantities of clear water. Acid and lye piping connections are equipped with sheet lead shields to prevent spraying.

Respirators are provided as protection against clay dust, gases and the like, and inhalators are always in readiness for sphyxia emergencies. In tank cleaning, one man is stationed outside and one inside, the latter equipped with a safety rope to help in his rescue if he is overcome by gas fumes.

Salt tablets are provided for workers as a preventive against heat prostration in refineries and oil fields.

In short, accident prevention has long since ceased to be a set of rules laid down by government boards or company management which workers are required to obey. Rather, "safety" has become a commodity, something to be preserved with the utmost care and which the worker appreciates.



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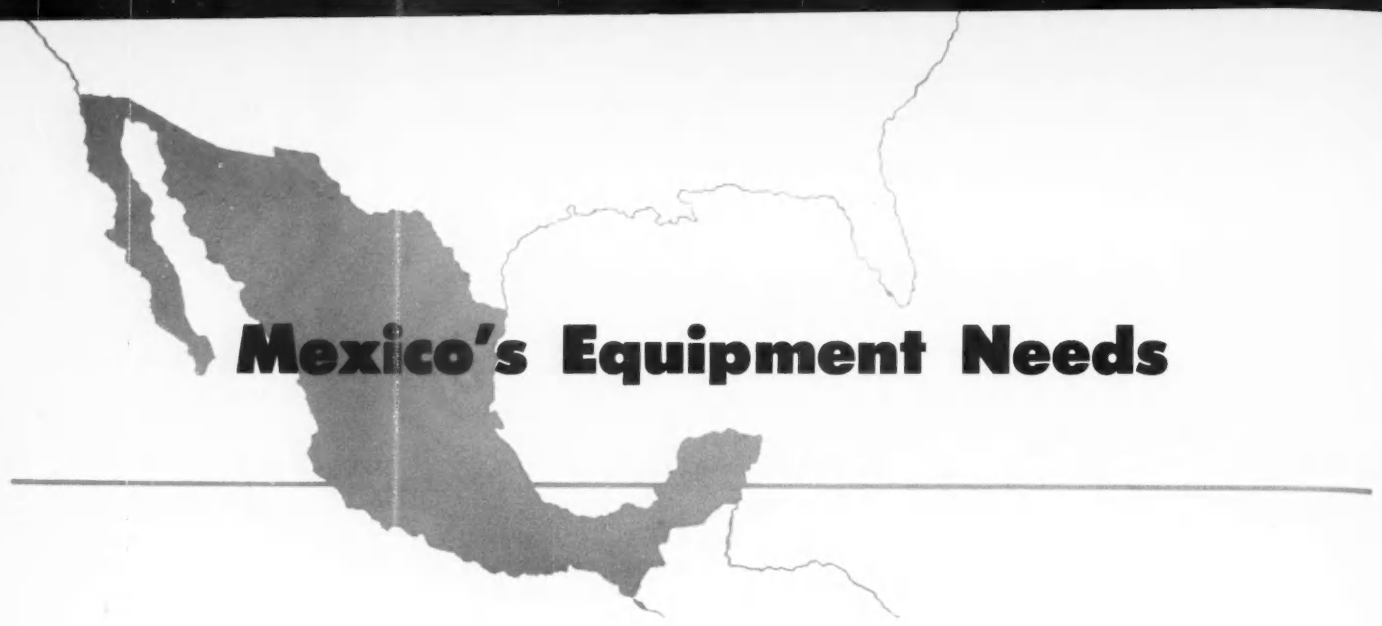


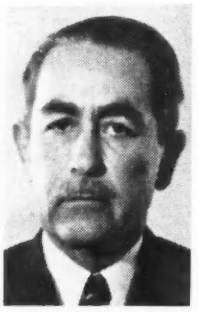
Mexico's Equipment Needs

PETROLEOS Mexicanos, Mexico's government-owned oil industry monopoly, is a financially sound corporation, doing a steadily increasing volume of business on a satisfactory corporate basis, carrying on expansion of facilities for supplying increased domestic and export demand, feeling an obligation to help supply oils for the international as well as the domestic market, but currently needing from the U. S. more materials and equipment than are being made available for purchase.

This is a summation of the present situation, philosophy, and paramount problem of Pemex as set forth by its director general, Senator Antonio J. Bermudez, in an address before a miners' convention at El Paso.

Because of favorable geology, Mexico should be a major producer of crude, in position to help supply the needs of other countries of the Western Hemisphere as well as all domestic requirements, said Bermudez, and the efforts of Pemex are being directed toward that end. While the Mexican petroleum industry has been remade under Pemex from one largely exporting its output to one distributing products mainly for domestic consumption, he added, the exporting facilities have been maintained and even improved.

"There is an international duty incumbent on Pemex," he said, requiring "that such wealth as developed should be available to our friends and allies in times of war for the proper protection of civilization and democracy and in times of peace to foster general prosperity and industrial activity. Mexico is determined to play its rightful part in the protection of civilization by insuring that its oil resources should be properly explored and conservatively developed and made readily available in times of international danger, in order that democracy can be preserved and our continent may continue to be the bulwark of law and order, of safety and peace. Pemex is conscientiously striving to achieve success in its part of this enterprise . . . Mexico only asks that the materials so necessary for the development of our industry, without which we cannot expand, be sold to us at this time, when they are needed badly."



Antonio J. Bermudez

Good Investment

Increased production of all mineral resources is essential to the welfare of humanity, and cooperation of Western Hemisphere nations towards this end will strengthen the ties of mutual friendship and good neighborliness among them, declared Bermudez. Furthermore, said he, "Helping us to invigorate our economic structure is good business, a good investment for America. You certainly would rather have a prosperous neighbor and a first-class customer, and that will be the case if we are able to overcome our present difficulties and successfully carry out our plans."

Bermudez outlined current and projected expansion projects of Pemex and gave estimates of the costs of each. He denied that Pemex operating costs are a burden on the federal treasury. On the contrary, he asserted, Pemex regularly and punctually makes important payments into the federal treasury, besides meeting obligations in compensation for properties expropriated. There has been prompt payment, also, he added, on the loan obtained from the Export-Import Bank of the U. S. for expanding the Mexico City refinery and related pipe line and other projects.

That refinery project and the first stage of related Poza Rica field installations required a total investment of $147 million Mexican currency, stated Bermudez, and of this amount $48½ million represents the cost of materials purchased in the United States and $98½ million the cost of labor, materials, and expenses in Mexico. The gross income to be obtained from the sale of refinery products amounts to $1,020,933 Mexican currency per day, and the operating cost and sales expenses amount to $730,649 per day, leaving $290,304 daily for amortization and profits.

The next project of Pemex includes a refinery of 30,000 barrels daily capacity in Salamanca, Guanajuato, and the pipe line to supply it. Purchasing of materials for the refinery is now under way. The pipe line is being constructed mainly with pipe manufactured in Mexico, the rest with American pipe, bought in advance, which is being received at present. This complete project will require an estimated investment of $95,486,000 Mexican currency, of which $39,897,000 covers imported materials and $55½ million represents labor, materials, and expenses in Mexico.

The first stage of the work carried out in Poza Rica, as part of the Mexico City refinery extension project, includes installations which will contribute to the servicing of a gas pipe line to Mexico City that will permit the transport and industrial utilization of 50 million cubic feet of gas daily. These installations will be complemented with others, said

■ CONTINUED ON PAGE 223

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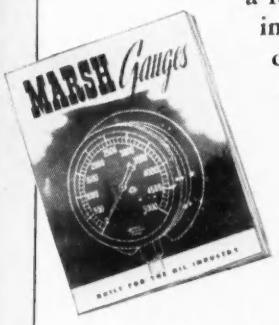

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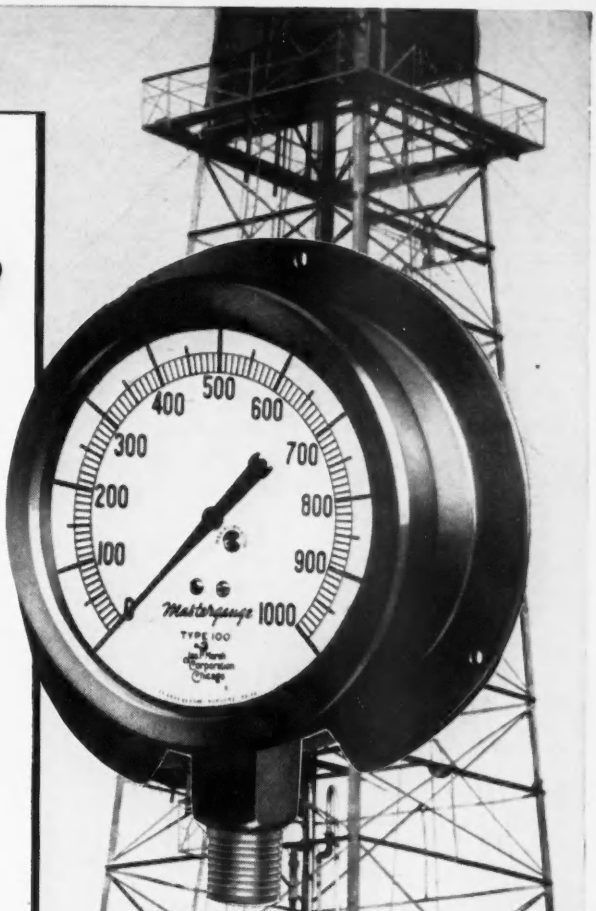

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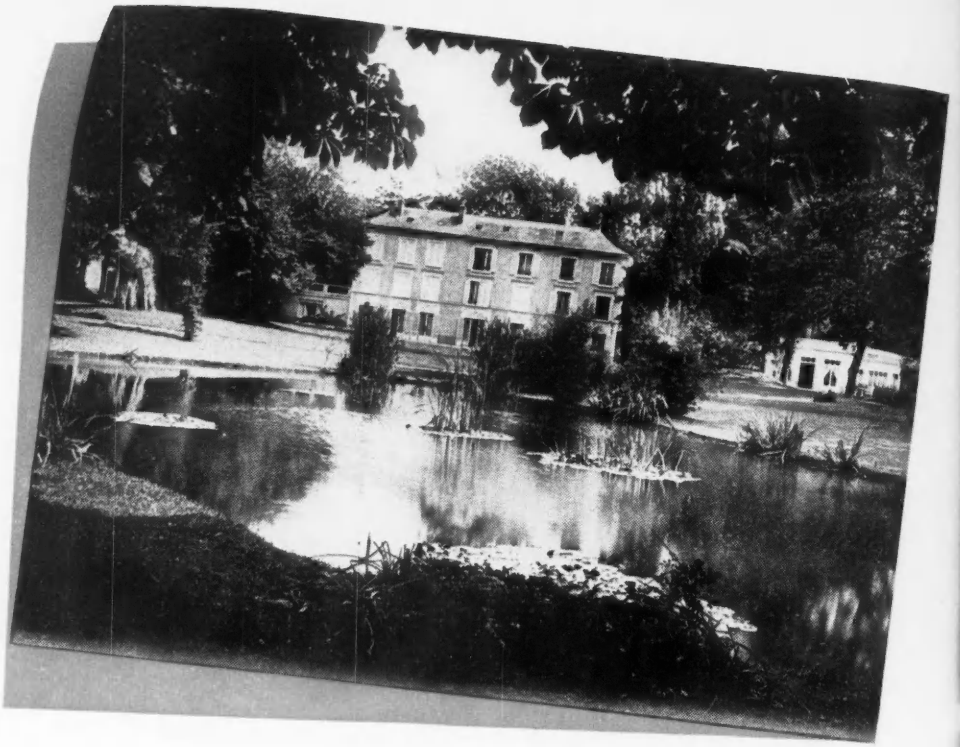

New Petroleum School and laboratories of the Institut du Petrole, just outside Paris.

Training for the Oil Industry IN FRANCE

THE French are carrying out an intense exploration program for oil and gas throughout the sedimentary areas of Southern France and also in the French colonies and dependencies overseas. The problem of providing trained French personnel for these operations is being solved by educating and training selected students under the direction of the Institut du Petrole in Paris.

This organization was formed in 1945 under the Direction des Carburants, a division of the Ministere de Production Industrielle as a French government agency to assist the French oil companies in their activities and to supervise the training of the necessary technical staffs.

Within the short period which has elapsed since its inception, the Institut du Petrole has done a remarkably successful job. Today the heavy rotaries operating in Southern France and the colonies are manned almost entirely by French drillers and roughnecks, and supervised by French engineers and geologists.

Before the war, the only French educational body which dealt with specific petroleum studies was the School of Petroleum at Strasbourg, which trained a limited number of engineers in the various branches of the oil industry. The majority of these graduates was then employed by French companies overseas or in the refinery industry in France, where prewar exploration and production activities were on a very small scale. On the evacuation of Strasbourg in 1939, the drilling and production sections of the school were moved to Toulouse, while the refining section went to Clermont Ferrand, in Central France. The Institut du Petrole has now taken charge of the petroleum schools and is setting up a special University of Petroleum at Rueil-Malmaison, a few miles outside Paris. Commodious buildings and laboratories have been obtained, and by the end of October all the educational divisions previously located at Strasbourg, Toulouse and Clermont Ferrand were functioning under one direction in the suburbs of Paris, under the title of the Ecole Nationale Superieure du Petrole.

The students entering this University of Petroleum are all selected graduates in engineering or geology who are admitted for a one to two years' specialized course in petroleum science. For the first term in Paris, 117 pupils were entered, divided as follows between the various branches:

1. Exploration and Exploitation Section.
   - A. Exploration (structural geology, sedimentary geology and geophysics), 49 pupils.
   - B. Drilling and production, 19 pupils.
2. Refining.
   - A. Refinery engineering, 19 pupils.
   - B. Physico-chemical research, 18 pupils.
   - C. Petroleum products, 12 pupils.

Field Experience Given

The training during these courses is both theoretical and practical, and for those concerned with exploration and exploitation comprises also considerable field work, which is continued during the vacations. Close liaison is maintained with

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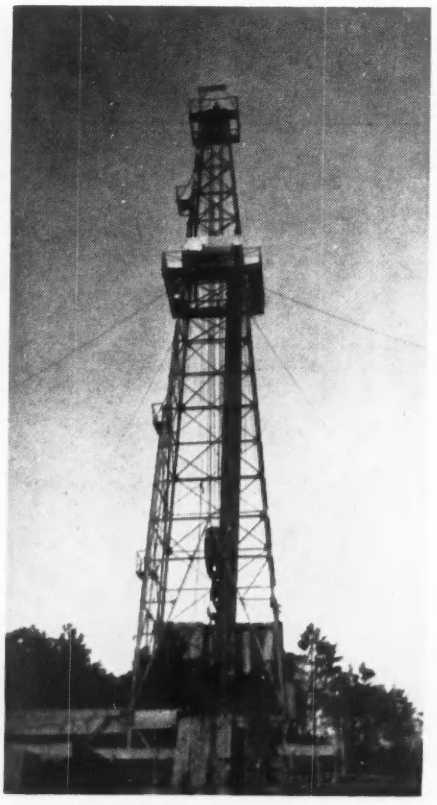
Institut du Petrole, Paris.

the oil companies operating in France, and students frequently are sent out for actual oil field experience. After the completion of their courses, the trained graduates are usually placed with one of the French companies who inform the Institut du Petrole of their requirements in the different branches from time to time.

Besides this ambitious and admirably executed program of training for petroleum engineers and geologists, the Institut also is responsible for the training of French drillers. It has been no easy task, but is none the less being successfully executed, as is shown by the fact that the rotary rigs drilling in France and the overseas territories are manned almost entirely by French drillers. Selected candidates who must be capable mechanics are chosen from applicants coming from industry or the armed services and sent to one of three drilling schools set up by the French oil companies in conjunction with the Institut du Petrole. One of these is operated by the S.N.P.L.M. at Caveirac near Nimes, one by the S.N.P.A. at Saint Sever in the Landes, and the third by the S.C.P. in Morocco.

At each of these schools trainees are given theoretical instruction in the principles of drilling and elementary geology and petroleum engineering. An intensive course on practical drilling occupies the remainder of the time, and each man is instructed on the rig in all the varied processes of modern rotary drilling, before actually handling the brake. These drillers' courses last about 1½ years and at the present time there are 38 students at Caveirac and 26 on the S.N.P.A. rig at Audignon. R.A.P. has been running a course independent of the Institut for several years at Saint Marcet, from which it turns out about ten assistant drillers every nine months.

The objective of this drilling training is to produce competent assistant drillers, who after about another year as assistant drillers on one of the companies' rigs will be competent to take charge of a shift. The best of the trainees from the drilling schools are sent for advanced instruction to the Drilling School at Sidi Slimane in Morocco, where they spend about three months on a new heavy duty rotary receiving additional training. There are 18 students on the rig at Sidi Slimane.



French drilling school operated by American drillers.

The provision of toolpushers has been a difficult problem, owing to the general lack of experience of French drillers, and at the present time the system is to have one toolpusher and one petroleum engineer responsible for each well. This obviously is an uneconomic arrangement, which will be remedied in time when more experienced men are available.

Other Functions

Besides the extensive work it is carrying out in the training of all grades of technical staff for the French industry, the Institut du Petrole has two other functions. The first of these is the collection, translation and distribution of scientific and technical information dealing with the oil industry; and the second is the carrying out of special research for the advancement of knowledge both on academic problems and on specific practical problems, requested by the French companies.

The Institut du Petrole also undertakes the sponsoring of special lectures by distinguished foreign specialists. Several well-known American oil men recently have visited France to give special courses of lectures and demonstrations to the Institut's students. For example, a professor gave a month's course on petroleum engineering, and an official of Standard Oil Company of Texas gave mud instruction in the field. Demonstrations were given on several wells in the use of formation testers, and a course of instruction on inclinometers. Instructors from a geophysical firm also came over under the auspices of the Institut du Petrole to instruct the French Geophysical Company.

Finally, the Institut arranges for special training in America of selected young French engineers. It has sent two students to the Missouri School of Mines for two years to graduate in petroleum engineering, and M. Ginestet to Tulsa to study refinery engineering for a similar period. The Institut pays all expenses for these selected students.

The director-general of the Institut du Petrole, whose Paris office is at 2 rue de Lubeck, is M. Jacqué, and the director is M. Navarre, assisted by M. Nougaro. E. D. Lynton, consultant, who has been advising the Institut since March, 1946, is responsible for much of its present success. Lynton's tour of duty in France is now nearly over, and he plans to sail for the U. S. A. on March 9.

Leaders in the Institut du Petrole

LEON JACQUE has been the director general of the French Institut du Petrole since its foundation in 1945. He was born in 1900 in Bilboa (Spain), and is a graduate of the Ecole Polytechnique. Between 1923 and the present time he has been successively demonstrator, lecturer and professor at the Ecole Polytechnique, and has published 40 papers dealing principally with the chemical properties of petroleum and refining problems. Between 1939 and 1940 he served in the Ministry of Munitions, and from 1940 to 1941 was secretary general of the Association of Plastic and Resin Producers. Since 1943 he has been president of the Committee for Petroleum Studies and also president of the Plastic Research Committee.

Leon Jacque

Jacqué has been the recipient of several awards, among them the special annual award given by the National Office of Combustible Liquids.

»

RENÉ NAVARRE is the managing director of the Institut du Petrole. Born in France in 1906, he graduated from the Ecole Nationale Superieure du Petrole and joined the French Standard Oil Company. In ten years' service, during which he visited the refineries and laboratories of Jersey Standard in the U.S., he was successively research engineer, refinery engineer at the Porte Jerome refinery, in charge of the Lubricants Department and chief of production.

Rene Navarre

During the last five years, Navarre has been directing various professional organizations in the petroleum industry, as for example the French Association of Petroleum Technicians of which he was president from 1943-1945. He has been particularly interested in the development of natural and synthetic lubricants, and in the training of petroleum technologists, engineers and drillers. In recognition of his services to the petroleum industry, Navarre has been the recipient of the Gold Medal of the Society for the Encouragement of National Industry.

»

JEAN-JACQUES NOUGARO was born in 1917 at Bayonne in the Basses-Pyrenees. He studied at the Ecole Polytechnique and specialized in petroleum engineering at the Ecole Nationale Superieure du Petrole between 1941 and 1942. For the next two years he worked for Regie Autonome des Petroles at Saint Gaudens. In August, 1944, he joined the resistance forces and later served as lieutenant of artillery during the invasion of Germany. He was awarded the Croix de Guerre.

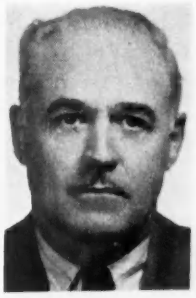
Jean-Jacques Nougaro

On demobilization in 1945, he rejoined the RAP and in April, 1946, he went to the Institut du Petrole in Paris to take charge of the Drilling and Exploitation Department where he has been working in collaboration with Ted Lynton.

During the last few months Nougaro has been particularly engaged in the training of drillers and engineers, and in organizing the visits and lectures of distinguished American technicians.

»

EDWARD D. LYNTON is consultant to the Institut du Petrole, which he joined in 1946. He has had a long and active career in the oil industry all over the world. Born in New York City, he was educated in England, France and Switzerland, and entered the oil business in 1919, going to the Tampico fields for Mexican-Eagle. In 1920 he joined Standard Oil Company of California as a geologist and engineer, and two years later was the first geologist sent to Texas by the company. From 1923 to 1926 he resided in Los Angeles and was assigned by the company to develop the use of the magnetometer. He was in the research and development department of Standard of California from 1931 to 1942. Lynton was appointed specialist on oil, mining and other industries for North Africa by the U. S. government in 1943, and for a year was chief of the Procurement and Development Division of the North African Joint Economic Mission in Morocco. He returned to the California Research Corporation, subsidiary of Standard of California, in 1945.



Edward D. Lynton

Mexico's Equipment Needs

■ CONTINUED FROM PAGE 214

Bermudez, that will allow a total extraction of natural gasoline from natural gas, the removal of sulfur from gas destined for fuel, the utilization of eliminated sulphur, and finally, the return to the formation of the volume of dry gas estimated necessary to repressure the structure, in order to obtain the best field production conditions and the ultimate maximum recovery. It is estimated that the required investment will be $61,580,000 Mexican currency, of which $20,860,000 covers imported materials and $40,720,000 labor, materials, and local expenses.

Development

The Pemex development program contemplated for the near future includes various tentative projects briefly tabulated by Bermudez as follows:

1. Lubricants and paraffin plant at the Mexico City refinery; total investment, $47,650,000 Mexican currency; daily net income, $103,500.

2. Pipe line across the Isthmus and refinery on the Pacific Coast; total investment, $33,150,000 Mexican currency; daily net income, $26,730.

3. Cracking plant at Tampico; total investment, $25 million Mexican currency; daily net income, $26,500.

4. Refinery at Guadalajara; total investment, $24,080,000 Mexican currency; daily net income, $16,400.

5. Refineries at Monterrey and Torreon; total investment, $100 million Mexican currency; daily net income, $70,443.

Bermudez labeled as false the idea that the Mexican oil industry under Pemex is a growing burden on taxpayers, that its operating costs lean upon the federal treasury. "The truth is," he asserted, "that Petroleos Mexicanos discharges its obligations out of its own income and furthermore that it shares in the public expenditures exactly and punctually in compliance with the existing fiscal regulations." Its payments to the federal treasury have been, he said, as follows: $41,196,013.02 Mexican currency in 1938 (March 19-December 31), $64,336,816.12 in 1939, $96,812,436.25 in 1940, $100,443,970.08 in 1941, $86,147,-

827.99 in 1942, $122,684,833.73 in 1943, $93,553,627.71 in 1944, $124,188,390.24 in 1945, $134,226,803.72 in 1946, and $165,800,000 in 1947 up to September 30.

Total income of Petroleos Mexicanos meanwhile has been as follows: $154,908,077.42 Mexican currency in 1938 from March 19 to December 31, $242,263,866.14 in 1939, $278,652,216.49 in 1940, $311,490,353.80 in 1941, $307,313,615.95 in 1942, $344,469,733.95 in 1943, $392,858,647.00 in 1944, $480,471,041.56 in 1945, $568,003,720.18 in 1946, and $569,700,000.00 in 1947 up to September 30.

As in the case of other enterprises engaged in extractive industries, said Bermudez, Petroleos Mexicanos uses total income to cover the full expenses of operation and maintenance, to pay for capital investments intended for the development of its activities, to pay taxes, and to meet other miscellaneous obligations. For Pemex, income also covers payment on indebtedness arising out of the expropriation of the oil companies.

To cover cost of the new Mexico City refinery and supplementary installations, a loan was negotiated with the Export-Import Bank of the U. S. for $48½ million Mexican currency, to be redeemed in five years as from 1946. To date, all installments on principal and interest of this debt have been met in due time and even paid in advance, said Bermudez.

In similar manner and for other self-redeemable projects, obligations have been incurred with the "Nacional Financiera," a Mexican public credit institution, for $80 million Mexican currency to be totally redeemed in 1952.

In further defense of the financial soundness of Petroleos Mexicanos, Bermudez quoted from the report of the auditors, an independent public accounting firm, who analyzed the company's general balance as of December 31, 1946, as follows:

"1. Petroleos Mexicanos has available sufficient cash, securities, and liquid assets to meet its immediate obligations.

"2. The total of its liabilities at short and long terms plus contingent liabilities are invested in negotiable credits of assured recovery and in fixed properties carried at a conservative valuation, thus leaving an ample surplus as investment of its endowment and the corresponding reserves.

"3. The current assets hold a ratio of 2.82 to 1 with short term debentures; the working capital has a ratio of 1.10 to 1 with short and long term liabilities; and the total fixed assets in relation with long term liabilities, contingencies and special reserves hold a favorable proportion of 1.7 to 1; therefore, all the above mentioned margins, as well as the other items of the assets not in connection with liabilities, imply judicious investments of capital.

"4. The fixed assets are burdened with excessive depreciation and amortization reserves. The policy followed to depreciate these properties shows severe judgment of the management. Therefore, if a revaluation were to be made of the fixed assets, a surplus would be obtained that should increase the capital.

"5. From the accounts commented upon in our report it is to be inferred that a condition of solvency exists, as well as an acceptable paying capacity.

"6. Based on the aforesaid, we are in a position to state that, in our opinion, the balance referred to adequately reveals the financial condition of Petroleos Mexicanos as of December 31, 1946."

McCarthy-Argentina Deal Talked After Texas Oil Man's South American Visit

Glenn H. McCarthy, prominent Texas oil operator, returned late in November from a two-weeks visit to Argentina, accompanied by several members of his technical staff. While there he had an interview with General Peron and also visited several of Argentina's active producing areas.

In speculating as to the reasons behind such a trip, and its possible results, several possibilities suggest themselves, all of which have to do with arrangements for McCarthy to enter Argentina as an operator on some basis. However, it must be borne in mind that there are not too many types of deals likely to be of interest to both parties.

One of the first to suggest itself is that McCarthy is interested in securing petroleum concessions for exploration and development. This is a possibility, although an extremely remote one. It is the strongly avowed policy of the Argentine government to keep its acreage in the national reserve and the country has consistently refused to change its laws to permit expansion of operating in restricted areas.

Another possibility is for a large-scale drilling contract, since only through an accelerated drilling program can Argentina hope to approach its goal for drilling and production in accordance with its published Five-Year Plan. It is known that talks have been held with American drilling contractors along these lines, but it doesn't appear to be exactly the type of deal to appeal to McCarthy.

What seems most likely to appeal to McCarthy, and still be acceptable to the Argentine government, is some arrangement whereby McCarthy might be placed in full charge of all or a substantial part of the entire program of expansion, with an opportunity to exercise the full scope of his organization's technical skills in oil finding and development. Such an arrangement would leave full title to all lands in the hands of the government, and probably would be worked out so as not to hamper the operations of the government's own great organization, the Yacimientos Petroliferos Fiscales. It would give the nation two companies instead of one engaged in exploring for oil in many areas hitherto little prospected.

Assuming that some such agreement is reached in principle, there arise numberless possibilities for systems of compensation as well as actual division and delegation of authority.

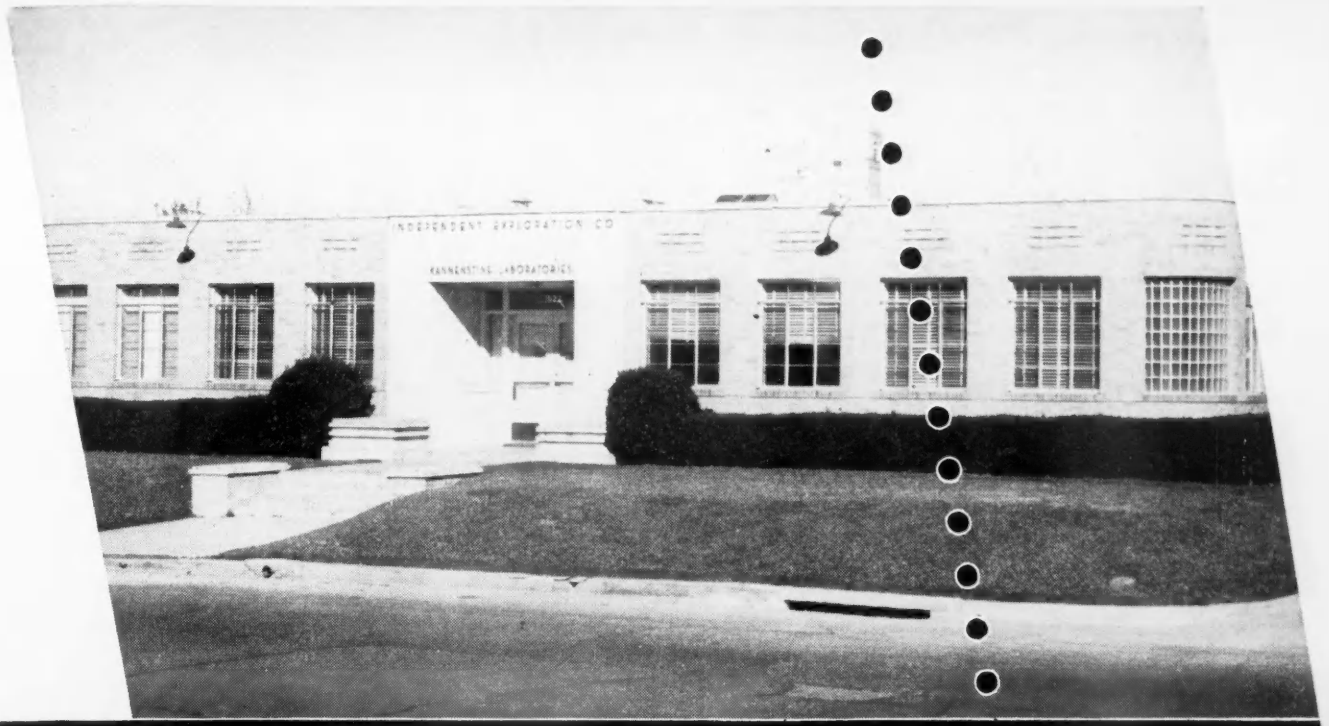
There are many ways in which these things can be worked out. However, a deal of this kind is rendered more difficult by reluctance of a country such as Argentina to execute an apparent reversal in its policies, and the necessity that it justify its moves within the limits of its announced policy. Rumor in the recent past has spoken of mixed companies with the government holding a controlling interest. It is not likely that an American company would enter into such an enterprise unless it received firm guarantees that it would have freedom of action and opportunity to exercise its own initiative.

In any event, everything points to one fact. Argentina must have more oil. Not only that, it must have more domestic oil in view of the constantly increasing percentage of imports of products and crude to support its industrial expansion. The administration has promised more oil production within five years and is now somewhat short of materials as well as trained technical personnel. It is logical that some action as that outlined above may be taken.

40 Wells in Argentina to Be Drilled by Texas Concern

First official action taken by Argentina in securing outside assistance in furthering its program of expansion of petroleum resources came in mid-December with approval by the Cabinet of a contract with Drilling and Exploration Company of Dallas.

The contract, according to information from Argentina, calls for the drilling of 40 exploratory wells on a contract basis for a reported consideration of $12½ million. It was agreed upon between the American firm and the agency of the government of Argentina early in the fall, but had to await Cabinet action.



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Venezuela Production at New High

New highs had been reached by Venezuelan production of crude when the country averaged 1,247,594 barrels daily for the first week in November. A new high was reached by Creole Petroleum Corporation, which had a daily average output of 609,701 barrels a day.

Indications pointed to maintenance of the producing rates at a high level as long as transportation facilities were available for moving the oil. With 142 drilling rigs operating at the beginning of November, 31 percent more than were working at the same time in 1946, completions for the first ten months of the year had already reached 641 wells, or within a few of the total drilled in 1946. At the same time, drilling had been extremely successful in establishing substantial new reserves, particularly as regards extension and stepout drilling in previously discovered fields.

All the principal producers registered new all-time producing highs during 1947, with the Shell Group reaching a new high almost each week for the past several months, due primarily to the prolific Cretaceous limestone production being developed west of Lake Maracaibo, where each well completed adds 6000 barrels or more to the daily output. Entry of Creole, Texas Petroleum Company and Mene Grande Oil Company to this Cretaceous area means boosted drilling and production rates. Shell had reached a total production of 372,239 barrels daily by the first week in November, while Mene Grande had raised its production to around 220,000 barrels a day.

Superior Unable to Agree With Bolivia on Contract

The Superior Oil Company and the Bolivian government have failed to agree on the contract signed by the company last year for exploration and exploitation rights on an area of about 10 million acres in the southeastern part of the country. The company has indicated that it will not take any further steps to obtain congressional ratification of the contract in view of conditions in the country which might fail to justify the great cost incident to continuation of the program. Only a relatively small amount of surface geology had been done at the time the decision was made.

The contract as originally drawn up and signed by Superior and the government ministry was deemed unacceptable by the congressional committee which had reviewed it. The committee expressed the feeling in its report that the proposed area was too much to be tied up by one company, and that it actually was enough for at least several firms. Congressional leaders agreed with this view and would not act on the original proposal. Superior then indicated it would not be interested in a smaller area, and would be willing to assign its interests to any other company. The government has indicated it will entertain proposals from responsible operators as long as the area sought does not amount to more than 2½ million acres.

The area being dealt for is southeast and east of that in which Camiri and other present production is located and would be a sizable portion of the territory considered as having oil possibilities.

Mene Grande Clears Ground For Refinery in Venezuela

Mene Grande Oil Company, subsidiary of Gulf Oil Corporation, has started clearing ground for construction of a refinery in the Puerto la Cruz area on the north coast of Venezuela. Construction will begin when housing for labor and staff has been built.

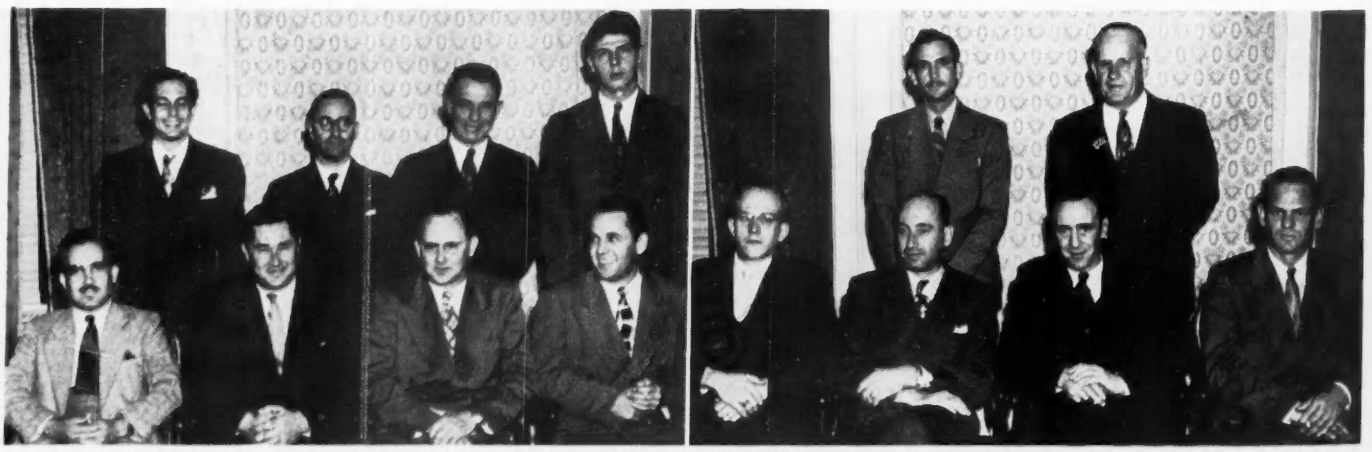
The plant is to have a throughput capacity of 20,000 barrels daily, an amount agreed upon through contract with the Venezuelean government at the time of the conversion of concessions in 1943.

Opencast Methods Increase Shale Output in Scotland

Opencast methods of shale mining, used in the West Lothian area of Scotland since July, 1946, have resulted in an average output per worker per day of 30 tons as against the average of five or six tons obtained by deep shale mining.

The present rate of production of opencast oil shale is about 15,000 tons per month and this, together with the wages reorganization policy of Scottish Oils, Ltd., has offset the drift of labor from the shale industry and enabled the Scottish refineries to keep working at full capacity.

Foreign Guests of Los Angeles Chapter of Nomads



Foreign guests at the November meeting of the Los Angeles Nomads were, at left, seated, left to right, N. Youssef, Shell Oil Company, Egypt; Juan P. Pedretti, Union Oil Company; H. C. Carroll, International Petroleum Company, Ltd.; Russell W. Keener, Petro-Tech. Service Company; standing, left to right, Carl A. Fernandez, Industrial Agencies, Ltd., Trinidad; Marcel Orgeval, SNPLM, France; George Emerick, Socony-Vacuum Oil Company; Benjamin Sttayne, Socony-Vacuum of Venezuela. At right, seated, left to right, Charles R. Wilkinson, Shell Oil Company, Colombia; Jean Didier Herrenschmidt, SNPLM, France; Ted H. Kopp, Iraq Petroleum Company, Ltd.; Walter L. Sears, Iraq Petroleum Company, Ltd.; standing, left to right, R. S. Webb; H. D. Huskey, Iraq Petroleum Company, Ltd. Other foreign guests present were Richard C. Reniers, Drilling & Exploration Company; and Shih-yoo Chow, Chinese Petroleum Company.

WELEX JET SERVICES

For An *IMPROVED* Casing Perforating Job

The charge carrier ready to be lowered into the hole. Jets are fired through the ports which are externally sealed to exclude well fluids and pressures. Ports on 3-inch centers or greater, at 120° phasing

A NEW well perforating process.

The jet process of casing perforating overcomes many of the limitations of older methods, and is used successfully in any well where gun perforating might be called for. The most important advantage is ***increased penetration*** . . . through heaviest casing, cement, and 9″ to 12″ into the formation. There is ***no bullet*** to plug the hole, or to stick in the casing and interfere with running of servicing tools.

Jet perforating charges operate effectively at well temperatures up to 350° F. Safe for well and personnel, as there is no danger of premature detonation . . . no splitting or bulging of pipe.

Thoroughly proven on the job.

Welex jet perforating utilizes the principle of the shaped explosive charge, which has been perfected for oil well perforating after several years of intensive research and actual perforating jobs on a great number of wells. The charge is small, weighing less than one ounce, and upon detonation a high velocity jet is formed which is directionally controllable much the same as a bullet. Both tests and field experience show that jet perforating penetrates much farther into the formation than any other known method.

Welex jet perforation service is particularly valuable to the operator who needs greater penetration.

Welex service trucks are fully equipped for complete independent field operation.

Write or Wire. If you have wells that have not responded satisfactorily to conventional perforating methods, write or wire Welex. Service available NOW. Information and quotations gladly furnished.

WELEX JET SERVICES

WELL EXPLOSIVES, INC.
FORT WORTH 9, TEXAS
3909 Hemphill St. Phone 4-3246

Products Line in Colombia Scheduled for Completion

Colombia's new products pipe line to transport petroleum products from the Tropical Oil Company refinery at Barrancabermeja to Puerto Berrio on the Magdalena River, was scheduled for completion early in December.

The first link in a system designed to make movement of petroleum products from refinery to consuming areas independent of wet or dry seasons, the line was constructed by Tropical Oil Company of six-inch invasion pipe of the type used extensively during the war. Although being built by Troco, the line is to be considered part of the properties attached to the DeMares Concession, and will revert to the government on August 25, 1951, when the concession agreement expires. Length of this leg of the system is 93 kilometers, or about 58½ miles. The government has announced that it will push the line to Puerto Salgar, an additional 88 miles, where it will connect with the railroad to Bogota, biggest consuming center. The line is to be used for transportation of gasoline and diesel fuel, and will release river boats and barges for transportation of additional products.

While the river remains the only means of transportation for products, a definite shortage is felt during the dry season when the river is low.

Two similar projects are planned. One is a products line from Puerto Berrio to Medellin, one of the principal industrial centers of Colombia; and the other from Puerto Salgar to Manizales. These probably will be built by the governments of Antioquia and Caldas, respectively, the two political subdivisions in which Medellin and Manizales are located.

England's Record-Depth Test Is Abandoned at 7500 Feet

The oil search in England continues under the auspices of D'Arcy Exploration Company (Anglo-Iranian Oil Company).

The Perlethorpe well in Nottinghamshire has been completed in the Millstone grit at 3750 feet without encountering oil or gas. The well at Coulsland in Midlothian (Scotland) has been completed at 1995 feet, but the gas production was disappointingly small due to the thinning of reservoir sands on the crest of the structure. A test at Farndon in Nottinghamshire to search for the sand which gave traces of oil in a nearby coal boring was unsuccessful due to the lensing of the sand body. A test is being drilled at Edgmond near Market Drayton in Staffordshire on a seismic structure. This has now reached 900 feet.

In the Formby area of Lancashire where shallow oil production had been obtained for a considerable time from a hidden structure, a test has been completed without success. At 6494-7480 feet a series of very hard quartzitic sandstones and siliceous shales was penetrated with the aid of diamond drills. At the latter depth Pendleside limestone (carboniferous) was entered, thus establishing that the overlying hard rocks belonged to the Millstone grit. The well has now been abandoned at 7500 feet, and is the deepest test in Britain, the previous record having been the 7476-foot Dukes Wood well in the Eakring area.

A test is to be drilled at Willesden, a north London suburb, to assist in the interpretation of the geophysical data accumulated by the gravity survey of Central and Western England.

British Steel Industry to Use Million Tons of Oil in 1948

The British steel industry will eventually account for 1,300,000 tons of the planned industrial consumption of 6 million tons of fuel oil a year, which is designed to save 10 million tons of coal annually. The work of conversion has been hampered by shortages but it is expected that consumption of fuel oil in the iron and steel industries will be running at the rate of 1 million tons a year by the beginning of 1948. Oil will be used mainly in open hearth steel furnaces previously fired by producer gas, thus saving, 1.7 tons of coal for each ton of oil used. However, it is not technically possible to use oil instead of coke in the blast furnaces which account for almost 60 percent of the industry's coal consumption.

Oil from Coal in Africa Passes Experimental Stage

Oil from coal in South Africa is well beyond the experimental stage. The Vereeniging plant, which is in course of construction, will incorporate the latest design and will produce 60 million gallons of gasoline and 9 million gallons of diesel oil a year within three years. The following figures show the details of production and refining of torbanite in recent years:

YEAR	Torbanite Retorted Tons	Crude Oil Barrels	Yield Bbl./ ton
1937	19,024	18,143	0.95
1938	33,000	36,861	1.12
1939	55,098	73,355	1.33
1940	55,747	72,544	1.30
1941	90,959	120,026	1.32
1942	123,031	182,090	1.48
1943	130,205	172,556	1.33
1944	126,030	172,863	1.37
1945	133,588	180,544	1.35
1946	124,133	160,946	1.30

Temporary Quotas Established For Alberta's Leduc Field

The Alberta Conservation Board has placed temporary quotas in effect for the Leduc field pending a two months' study upon which will be based a conservation formula. The quotas are 150 barrels daily per well from the D3 zone and 100 barrels daily from the D2 zone of the Devonian.

The Leduc field, discovered by Imperial Oil last February, has had about 30 successful completions, all with natural flows ranging from 400 to over 2500 barrels per day. Prior to the temporary quotas, operators had been producing their wells at rates ranging from 100 to about 350 barrels daily.

By mid-February it is hoped to gather sufficient data to permit establishing of a maximum efficient production rate for each well.

D3 zone has an oil column about 38 feet thick, overlain in higher parts of the structure by a gas cap, and underlain by water. Original reservoir pressure is about 1895 pounds per square inch. The zone has a combined gas and water drive and, under conservation, a high percentage of the contained oil should be recoverable. As a tentative guess, ultimate average oil recovery might be 10,000 barrels per acre.

D2 shows variable porosity. Average thickness of effective porosity at wells placed on production to date is about 35 feet. There is some evidence of water drive. D2 has no gas cap. Gas dissolved in the oil is being produced at ratios from 300 to 500 cubic feet per barrel. Original reservoir pressure is about 1770 pounds. Average oil recovery per acre may be around 5000 barrels.

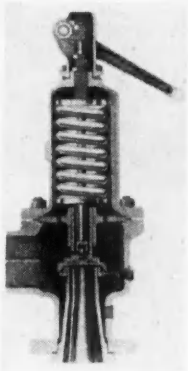
Due to pressure differentials and other factors, no attempt is being made to produce a Leduc well from both Devonian horizons. The Conservation Board has authorized the drilling of two wells per 40 acres in sections of the field where both zones have been established as oil-bearing.

Agreement Between French And Italian Firms Reported

An agreement reportedly has been reached between the French Compagnie Francaise des Petroles and the Italian APRI-Deliom group whereby the French firm is to participate in the Italian firm to the extent of 30 percent in the form of oil products. The Azienda Petroliferi Riuniti Italiani refinery at Genoa is to be used, operating on crude moving directly from Iraq, but these supplies probably would not be available before 1952, since it may be that long before the French share of Iraq Petroleum Company's production exceeds the home demand.

NEW EQUIPMENT and Literature

1—Safety-Relief Valve



Designed for inlet pressures up to 2000 pounds and temperatures to 900° F. and for handling corrosive liquids, vapors or gas is a new safety-relief valve. Designated as Type 2680, the valve is made of cast steel with stainless steel trim. A high disc lift permits full capacity discharge. Nozzle body is of long neck construction to permit proper nozzle flow without restriction. The body is fully ribbed to absorb piping stresses.

The combination of nozzle and inverted cone or secondary nozzle makes full use of the kinetic energy of the discharge to effect the high lift and full capacity without need of adjustments. The manufacturers state that this, coupled with a coefficient of flow efficiency established at 97½ percent means a smaller valve can be used. Long, low-stressed, protected loading spring maintains accurate set pressure. The new type valve is available in sizes from 1½ by 2 inches to 6 by 8 inches.

For additional information write Farris Engineering Corporation, 480 Commercial Avenue, Palisades Park, N. J.

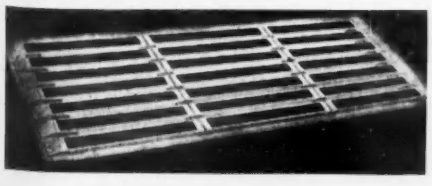
2—Safety Mat

A new type of industrial safety mat possesses a surface that is unaffected by oil, grease, gasoline, water, most acids and alkalis. The mat is a development of the link wood block mat widely used in all types of industry, and is surfaced with Minnesota Mining's "Safety-Walk" which is being used widely where non-slip surfaces are required.

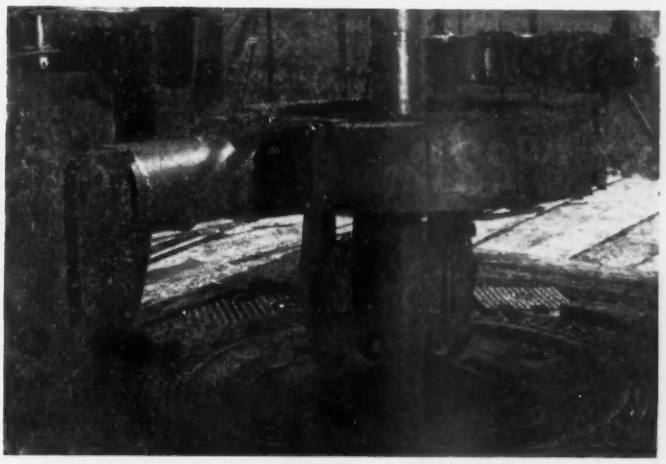
Safety-Walk is used in the oil industry at pipe line terminals on drawbridge type ramps to tank trucks. It also is in use on the top of tank trucks and at automobile service stations, because it remains non-slip regardless of the amount of oil spilled on it. "Safety-Walk" will not cut or wear shoe soles.

The new mat is constructed of seasoned hardwood cleats 2½ inches wide which are linked with cadmium-plated wire and plates. All tubing spacers are brass.

For additional information write National Mat Company, Inc., 110 Kingsley Street, Buffalo, N. Y.



3—Power Slips



Relieving the crew of one of the most grueling and tiring of drilling chores and greatly increasing safety in handling drill pipe are the new "Super Speed" power slips, said to save four to six minutes per 1000 feet of well depth.

The power slips are installed by cutting a rectangular hole in the derrick floor to admit the operating post which is bolted to a foundation beam. An operating pedal unit is bolted to the floor for use by the driller and a compressed air connection is made to available air lines or to a small compressor. The slips require 2½ cubic feet of air per minute during operation.

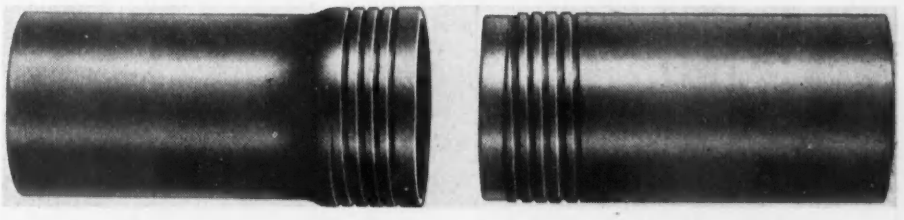
To engage the drill stem, the driller depresses a control pedal which lowers the slip to grip the pipe. Elevators lift the pipe, and a pressure on the other control pedal raises the slips. So rapid is the lowering process that if elevators should fail and drop the drill stem when the slips are open, a quick pressure on the proper control will in many instances drop and close the slips in time to catch the pipe.

An advantage claimed for the new slips is utilization of the standard one-piece rolling dog slips by substitution on the hand slips of new handles equipped with rollers.

Wear on rollers is eliminated because they make no contact with the lifting ring while pipe is spinning, and workmen are protected from injury by the stationary lifting ring which covers the rotary and shields the men from the spinning slips.

The handling unit, consisting of operating post and lifting ring, is manufactured in only one size, but handles all sizes of drill pipe from 2⅜ to seven inches in diameter through the use of different slips and rolling dogs. Clearance of the slips when open is enough to pass tool joints, pipe protectors, tubing catchers, drilling bits, etc.

For additional information write Mission Manufacturing Company, Humble Road, Houston 14.



4—Shot-Hole Casing

Eliminating independent couplings between joints is the new shot hole casing which is available in three-inch outside diameter. The casing is made from 16-gauge electric-weld tubing in lengths from ten to 20 feet. To achieve integral joint construction, the box end of each joint is expanded. The pin end is also expanded slightly to give a nominal inside diameter clearance of 2⅞ inches, and tapered to effect a positive seal. Heavy, square type threads, four to the inch, are then cold rolled into both ends, thus avoiding damage to the physical properties of the tubing.

The rolled-in threads do not reduce the wall thickness, yet are matched easily by any machine shop should fitting be required. The heavy, square-type threads are rugged, and make up and break out easily. Greater strength is said to result in greater recovery. Constant inside diameter with no projections eliminates sticking or hanging the explosive charge in the casing.

The outside diameter of the box is approximately 3¼ inches and the length approximately 1⅝ inches. The joint strength average is 15,000 pounds and is leak-proof up to about 250 pounds per square inch pressure.

For additional information write Jones & Laughlin Supply Company, P. O. Box 2481, Tulsa.

PENBERTHY

"REFLEX"

DROP FORGED STEEL LIQUID LEVEL GAGES

Liquid always shows black—empty space shows white. Preferred where the liquid level must be easily and positively visible, and when liquids are under high pressure or at high temperature. Made of alloy temperature resisting steel and are highest quality throughout. Liquid chamber made from solid block of steel to assure perfect alignment and rigidity. Conform with A.P.I.—A.S.M.E. requirements.

The "Reflex" is one of the complete line of Penberthy Gages that meet every liquid level gage requirement.

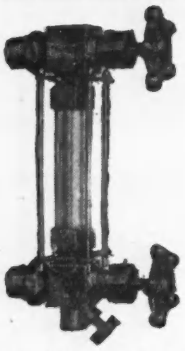
PENBERTHY INJECTOR CO.

DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY

"ALL IRON"

LIQUID LEVEL GAGES



Body made from a special high strength alloy iron, shanks alloy steel and trim stainless steel. Extra heavy construction throughout, automatic and positive shut-off if glass breaks, heavy duty stuffing boxes. Conform with A.P.I.—A.S.M.E. requirements.

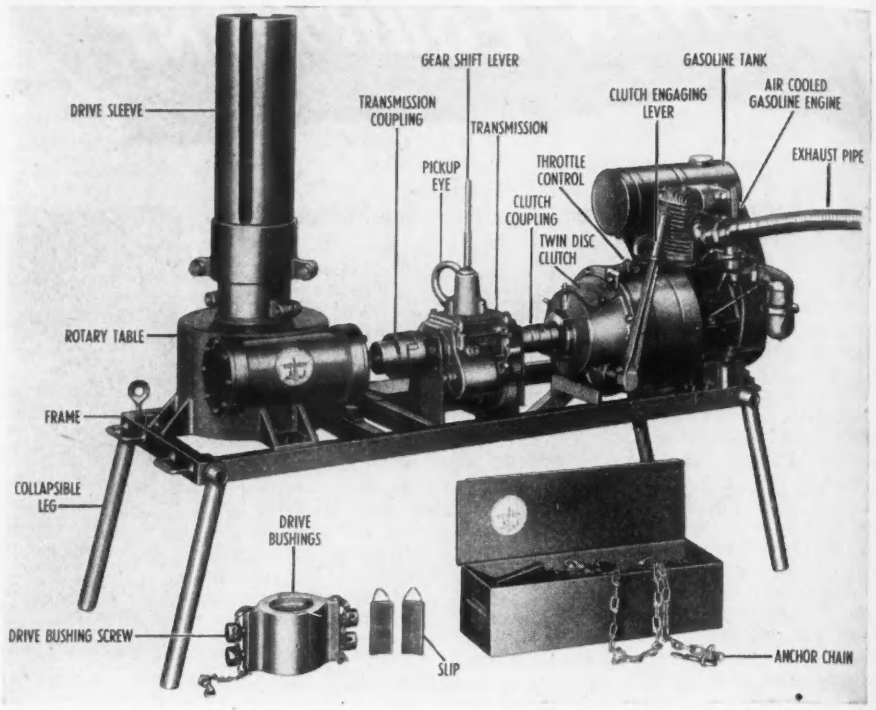
The "All Iron" is one of the complete line of Penberthy gages that meet every liquid level gage requirement.

PENBERTHY INJECTOR CO.

DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

NEW EQUIPMENT

LITERATURE



5—Portable, Powered Rotary Table

Eliminating the need of moving in and rigging up heavy rotary equipment for light, short-time rotary operations is the new portable and powered rotary table. It is a frame-mounted unit providing a powerful, sensitive rotary drive for such operations as the internal milling or cutting of casing, drill pipe and tubing, drilling out cement or other obstructions in casing or tubing, backing off sucker rods, and tubing, etc. Operation is simple, and its sturdy construction permits movement from rig to rig on a light truck.

Prime mover for the rotary table is an air-cooled gasoline engine mounted in line and connected to a heavy duty twin disc clutch. The clutch is coupled to a heavy-duty transmission providing three geared speeds forward and one geared speed in reverse. The transmission is coupled to a worm driven rotary table having a slotted drive sleeve. The entire unit is mounted on a rugged frame to facilitate moving from rig to rig on the bed of a pickup or light truck.

After the drilling or cutting string has been run in to the working depth, the complete unit is hoisted to a height sufficient to slide the slotted drive sleeve over the top joint of the working string. Once the pipe is centered in the drive sleeve, the entire unit is lowered to the floor and anchored by chaining opposite corners of the frame to opposing derrick legs. After anchoring the unit, slips of the proper size are installed in the two halves of dove-tailed type drive bushings and the two halves made up on the string by tightening the drive bushing screws. Slips are available to fit from 3½-inch outside diameter pipe to the smallest sucker rods. The working string is then lowered until the ears of the drive bushings are located within the slots of the drive sleeve.

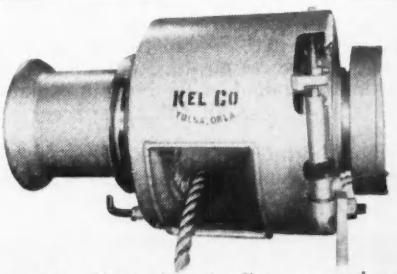
With the ears of the drive bushings held in the drive sleeve slots, the string can be rotated and lowered under torque the length of the slot in the drive sleeve. Continuous operation is possible at the top of the drive sleeve. The string may be rotated and elevated under torque by locating the drive bushings at the bottom of the drive sleeve slot.

For additional information write S. R. Bowen Company, P. O. Box 427, Santa Fe Springs, Calif.

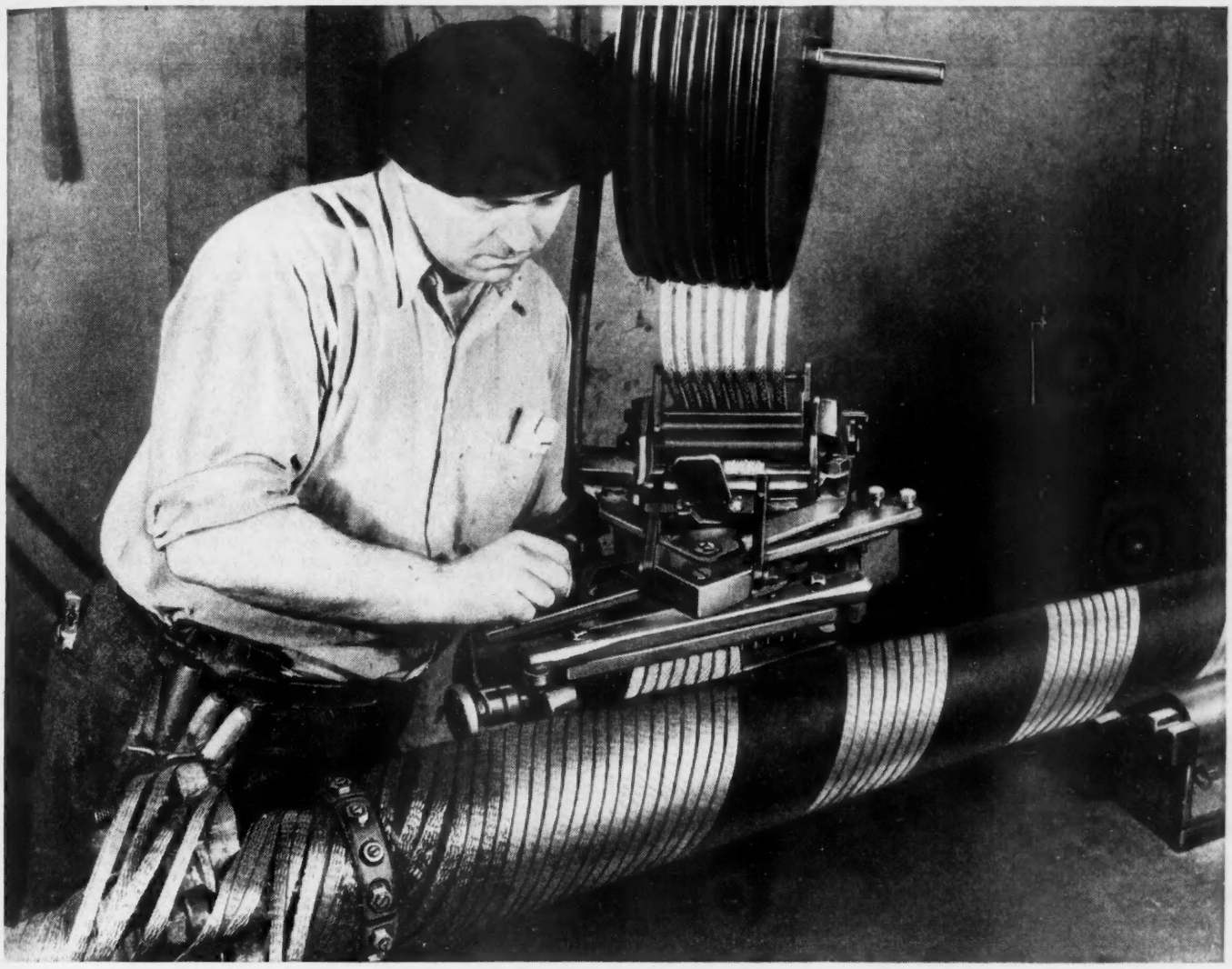
6—Non-Fouling Cathead

The new Kelco Model 16 Non-Fouling Cathead is said to be one of the major developments in cathead design since the introduction of the first spinning line unit. The catline spool is anti-fouling and of simple design, being the only part of the new model that is not enclosed. It may be removed to meet road clearances when transported with the drawworks without disturbing operation or adjustment of the friction cathead.

The friction cathead employs a double-plate clutch for softer action with maximum pulling power. The clutch, roller on inclined plane, cannot be improperly adjusted and offers exceptional power and sensitivity with immediate, positive release.



For additional information write Ben F. Kelley Company, P. O. Box 247, Tulsa.



The triple wrap that takes the rap

We're talking about the *three layers* of high-tensile braided bead wire that reinforce the carcass of Monarch Rotary Drilling Hose.

That triple wrap is only one of the many reasons why you see this famous, time-proved hose at work in oil fields everywhere. Because of it, Monarch Rotary Drilling Hose is able to withstand the extremely high pressures encountered in deep-hole oil well drilling.

And it's built to resist the abrasive action of drilling muds, too. What's more, you will find its tube is made of a special-purpose synthetic rubber that is built to resist oil. Leakproof, built-in couplings developed by Hewitt are securely anchored to the duck and wire wall reinforcement, providing a continuous, smooth, unrestricted fluidway throughout the entire hose length. And Monarch's tough strip-proof cover is highly resistant to abrasion, weathering and sun-checking.

Moreover, when you use Monarch Rotary Drilling Hose with Monarch Rotary Drilling Flexible Discharge Hose (between slush pump and standpipe), you're sure of a trouble-free combination that can withstand abuse of heavy-duty drilling operations.

Find out how this team can help *you*. Write for details. Or consult your nearest Hewitt distributor:

Mid-Continent Supply Company • Norvell-Wilder Supply Company • Jarecki Manufacturing Company Standard Supply & Hardware Company • Bethlehem Supply Company of California • Knight Manufacturing & Supply Company.

You can depend on your oil field supply specialist

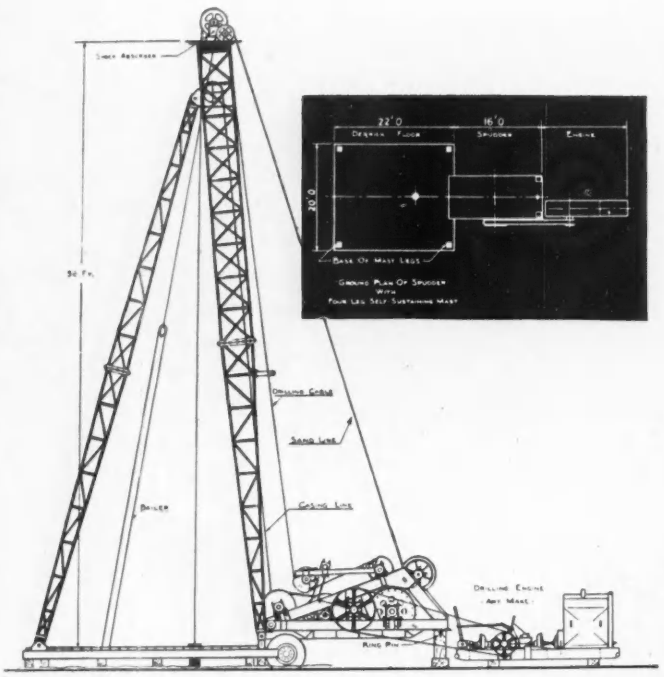
He's always ready to serve you. And he knows your job . . . your operations . . . your problems. Call on him at any time for advice. He'll recommend the exact Hewitt product especially designed to help *improve* the efficiency of your operations.

HEWITT RUBBER
DIVISION
HEWITT-ROBINS INCORPORATED
INDUSTRIAL HOSE • BELTING • PACKING

Monarch Rotary Drilling Hose

7—Spudder

The Model 6 spudder offers easy portability, simplified servicing and reduction of fire hazard. The spudder may be used with any engine with sufficient power for 6000-foot drilling. The engine is connected to the shaft of the spudder by means of a belt drive. Length of the belt drive determines the distance from the engine to the well, making it possible for the operator to set the engine as far back from the hole as he desires, thus decreasing the possibility of fire.



Four pneumatic tires on the rear axle give stability on roads, while the low center of gravity reduces possibility of upsetting. The axle can be changed from an 82-inch to a 72-inch track. Overall dimensions of the frame are 17 feet by 8 feet. A mast, suitable to the territory in which the unit is to be used, is equipped with a shock absorber and is self supporting, requiring no guy wires. Other types of masts can be furnished, or the spudder may be used under a standard derrick.

For additional information write Young Engine Corporation, Canton, Ohio.

8—Weatherproofing Material

A tough, elastic coating material for "weatherproofing" outdoor metal surfaces has been designed to simplify the long-term maintenance of storage tanks, bridges, transformers, water towers, harbor buoys, and other steel structures. This new material, called "Dum Dum for Metal," provides a durable coating many times the thickness of paint that makes the metal surface to which it is applied impervious to measurable vapor and moisture transmission, acid and alkali gases and fumes and other similar causes of deterioration, thereby preventing surface corrosion and disintegration due to these conditions.

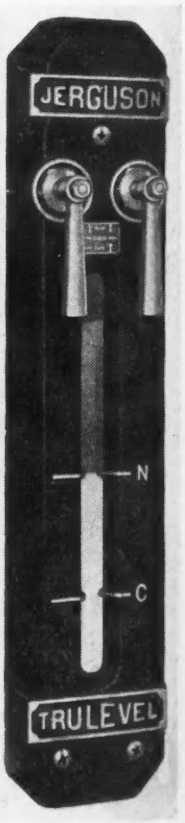
Economically applied by spray method for complete, uniform coverage and maximum protection of surfaces (particularly angles, corners, rivet heads and other similarly difficult areas), this weather-resistant, water-repellent compound may be used with minimum surface preparation on both new or uncoated metal structures and over previously coated surfaces. However, the material is not recommended for use over bituminous-type coatings.

In addition to giving greater protection against weather hazards to outdoor metal structures and improving their appearance, the material is also said to make possible substantial savings by lengthening the normal maintenance cycle. Whereas ordinary rust-and-corrosion-inhibiting coatings generally afford a satisfactory margin of protection for a three-to-five-year period, the pliable yet durable coating obtained with this Arco compound will provide dependable protection against weathering for ten years or more, it is said.

Packaged in 55-gallon drums and five-gallon pails, Dum Dum for Metal comes in aluminum color. Further details and specific application data are available on request to The Arco Company, 7301 Bessemer Avenue, Cleveland 4, or 745 East 59th Street, Los Angeles.

9—Boiler Level Gauge

The new Trulevel Gage was designed to be read and quickly checked at a remote reading point. The patented checking feature makes it necessary only to turn the two checking valve handles on the cover in order to check the water with complete accuracy in a matter of seconds. This remote reading and checking of boiler water level is guaranteed correct, according to the manufacturer, because the Trulevel Gage is provided with a new type of datum column located at the drum. This datum column is fully jacketed, duplicating the temperature and specific gravity conditions existing in the boiler drum.

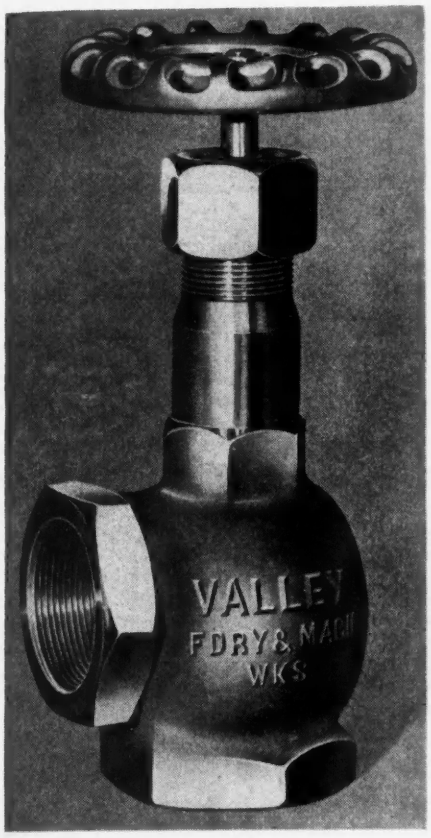


For additional information write Jerguson Gage & Valve Company, 80 Fellsway, Somerville 45, Mass.

Gotkool
WATER CANS
& COOLERS
GOTT Water Coolers are the convenient way to keep drinking water handy to the worker, protect it from impurities. Their exclusive construction keeps water cool for long periods. Snug fitting large removable top, handy non-leaking push button faucet. GOTT Water Cans for handy field use. Your Supply Store has them, get one today! . . . .
GOTKOOL WATER COOLER
Made in 2, 3, 5, 8, 10, 15 and 20 gallon sizes with Push-Button Faucet.
GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. (Push-Button Faucet at slight additional cost.
H. P. GOTT MFG. CO.
WINFIELD, KANSAS
KEEP PURE DRINKING WATER ALWAYS HANDY

10—Stainless Steel Angle Valve

A new stainless steel angle valve with rising stem is of 18-8 MO, type 316, and is now available in 1½, 2 and 3-inch sizes. A renewable valve seat of neoprene, hard rubber or fiber is provided. A specially designed swivel allows pressure to be applied in closing without turning the valve on the seat and therefore eliminates cutting or abrasive action. The manufacturers say the valve also eliminates the need for additional stainless steel fittings on many applications.

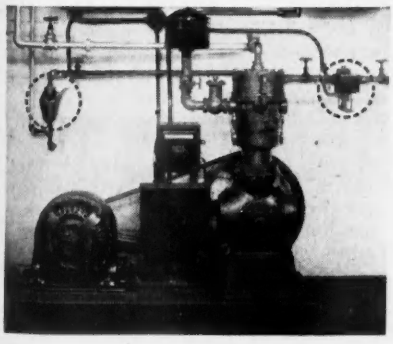


For additional information, write Valley Foundry & Machine Works, Inc., Fresno, Calif.

11—Solenoid Valve

Complete automatic control of the water supply to water-cooled compressors to prevent dangerous overheating and at the same time effect considerable water savings is provided by the new direct-operated solenoid valve.

A heavy-duty valve, it was developed to make the simple design and quick opening of solenoid valves available for a really practical range of services.



It handles temperatures up to 400°F. and in some sizes will operate under differential pressures up to 150 pounds. It is being used very successfully on boiler feed lines, and for a wide variety of automatic flow control applications.

In the Johnson Compressor Control, the valve is used to admit water to compressor when the regulator on storage tank calls for more pressure. The compressor itself is not started until water flows through the compressor and completes an electrical circuit with an electrode mounted in a holder on the discharge line.

If water doesn't flow for any reason, the compressor will not start, or if operating will stop immediately. When receiver is satisfied, compressor is stopped and the solenoid valve shuts off water at once.

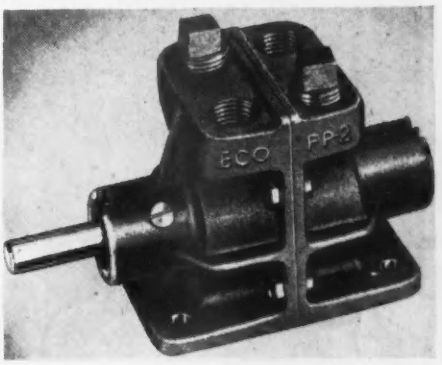
This Johnson Control also can be furnished for use with unloading compressors. In all cases it protects against the compressor operating without cooling water, and yet prevents unnecessary waste of water.

For additional information write the Johnson Corporation, Three Rivers, Mich.

12—Gearless Pump

Based on the principle of ECO gearless pumps, the newly designed pumps include several special features and improvements which make them ideal for handling practically all types of liquids. Chief among the improvements is their new double impeller design which gives a strong flow against pressure.

The new pumps are smooth running. Bodies are now available in stainless steel, monel and bronze to meet a wide range of industrial conditions. Body of pump is stated by the manufacturer to last indefinitely. Every wearing part of the pump can be easily replaced. All pump parts which come in contact with the liquid handled can be adapted for that special purpose.



The impellers of the pumps can be adapted to the operation involved. Special impellers can be provided to suit the particular characteristics of the liquid being handled. Impellers are tough and long-lasting, being made of special wear-resistant materials.

They are available in ¼ and ½-inch sizes, capacities from one to 12 gallons per minute varying with pump speeds and pressures. Pumps can be used against pressures up to 50 pounds per square inch and they can be run and will deliver at speeds from 200 to 3500 revolutions per minute.

The pumps are versatile in that they can be used in various positions and for a wide number of operations. Fitted with self-lubricating bearings, they eliminate problems of lubrication and give freedom from pump grease of oil fouling intake and discharge lines.

For additional information write ECO Engineering Company, 12 New York Avenue, Newark 1, N. J.

the truck with the "show-how"

Sometimes people just don't believe what we tell them about HOMELITE Pumps, Generators and Blowers. Frankly, we can't blame them, because the *heavyweight* results you get with these *lightweight* units are hard to believe — until you're shown. That's why HOMELITE has a fleet of "Show-How" Trucks: to bring them right to your location to *demonstrate* how they out-perform others pound-for-pound of weight and inch-for-inch of size. A telephone call or letter will bring a "Show-How" Truck your way. Write or call today. No obligation, of course.

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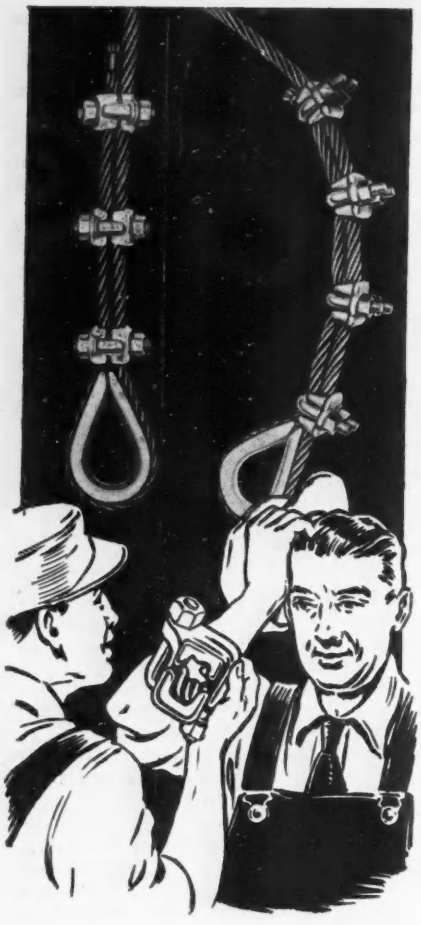

"Get This Straight"

"A bowed rope is a weakened rope, Mac . . . those 'Finger Pinch' U-Bolt Clips crush and bend the rope . . . make the load *uneven* — some strands are overloaded . . . others don't carry their proper load. Results: premature rope failure . . . higher rope costs . . . lessened efficiency. Replace 'em with Laughlin 'Fist-Grip' Clips — they'll make your rope straight like *this* one, because their flat bearing surfaces give uniform pressure over the entire contact area. 'Fist-Grips' are easy to put on, too, Mac . . . even new men like yourself get 'em right the first time because they come in identical halves — you *can't* stagger 'em. Furthermore, three 'Fist-Grips' do the work of four U-Bolts, so you save time. Ask the Supply Room boys for 'Fist-Grips' . . . they prevent many a headache."

"Fist-Grip" Clips are available at your supply house. Look for the "L" trade-mark. Write for fitting catalog: Dept. 23, The Thomas Laughlin Co., Portland 6, Maine.

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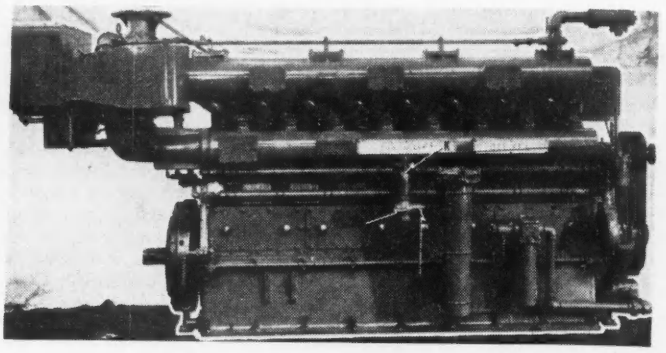
THE MOST COMPLETE LINE OF DROP-FORGED WIRE ROPE AND CHAIN FITTINGS

NEW EQUIPMENT LITERATURE

13—Supercharged, Dual-Fuel Engine



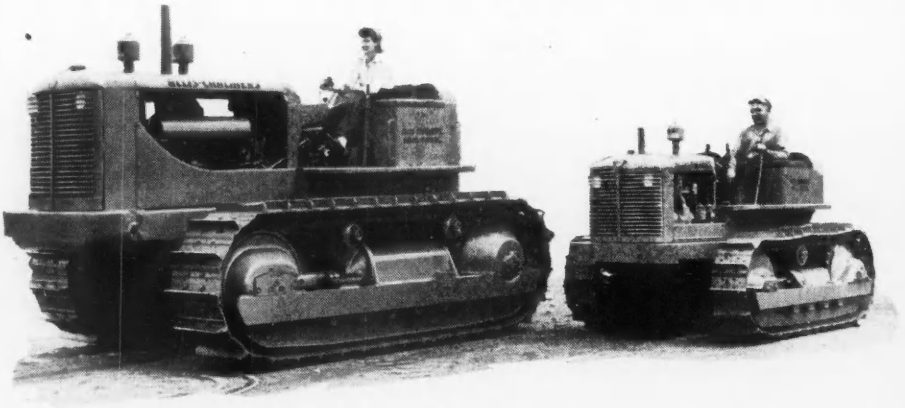
Two independent developments in the design of diesel engines have widened the application of the diesel in drilling oil wells. Both turbo-supercharging and dual-fuel operation have now been applied successfully in the PTDS-8, illustrated, a new engine for the drilling industry. Dual fuel engines permit flexibility of engine operation on either oil or gas. These engines are convertible from one fuel to the other while the engine is running.

Supercharging increases the power output of a diesel engine as much as 60 percent or more with only about 15 percent in weight. The weight per horsepower is reduced about 40 percent. Superior engines are supercharged by the Elliot-Buchi turbocharger, which consists of a gas turbine operated by engine exhaust gas on its way to the atmosphere and has no connection with the engine crankshaft. A blower on the same shaft with the turbine supplies scavenging and combustion air to the engine cylinders at a pressure greater than that of the atmosphere. Speed and output of the turbocharger vary automatically with engine speed and load, or both, making control equipment unnecessary.

The problem of introducing gaseous fuel into a supercharged dual-fuel engine, created by scavenging at the end of the exhaust stroke, was solved by a novel gas-injection system. The starting air check valve for dual-fuel engine operation is used for injection of gaseous fuel. This makes the heads of straight diesel and dual-fuel engines interchangeable.

The dual-fuel engine is said to be even more economical than the straight diesel at loads greater than 75 percent of full load, and at full load this saving amounts to about 17 percent. It is interesting from a technical point of view that the relatively high percentage of pilot oil results in better economy than when minimum pilot fuel is used under controlled conditions.

For additional information write The National Supply Company, Toledo 1, Ohio.



14—Crawler Tractor

The HD-19 crawler tractor, shown alongside a regular heavy-duty tractor, employs a three-stage hydraulic torque converter in the power train which permits the horsepower output of the engine to be held near a maixmum. Operating adjustments, maintenance points and major assemblies are so located and designed that the care, maintenance and repair of the tractor can be accomplished with the least effort and loss of time. Positive-seal grease-packed truck wheels, idlers and support rollers are serviced at the factory and thereafter require greasing attention only once every 1000 hours.

The torque converter is said to provide longer life since it eliminates shock that always results from master clutch engagements in conventional tractors as well as thousands of other instantaneous loads throughout each day's operation. Both breakage and wear of the tractor and allied equipment are greatly reduced due to this cushion effect of the converter. Hydraulically powered steering levers that offer fingertip steering control take most of the physical labor out of driving the tractor.

The HD-19 transmission has only two forward speeds and one reverse. A track tread of 84 inches plus 8 feet, 10⅝ inches of track on the ground provide excellent ground contact, balance and traction. It also features 16 inches of ground clearance.

For additional information write Allis-Chalmers Manufacturing Company, Tractor Division, Milwaukee 1.

THE LAYNE
Wire Wrapped
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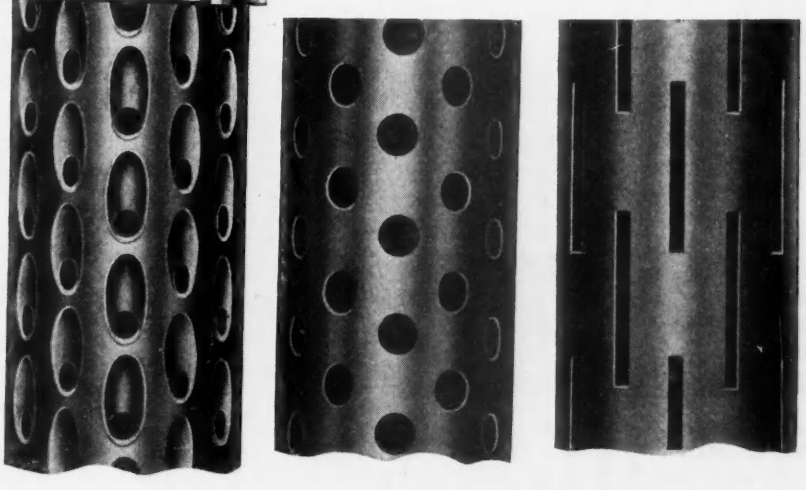
ADAPTABLE TO EVERY SAND PROBLEM

When you need a screen you need the best—and it should be especially adaptable to your particular sand problem.

In the Layne Screen you have the choice of three openings; milled groove, plain drilled, or slotted. Each has its place in the field.

Regardless of the openings desired, each Layne Screen is precision made with accurate and uniform openings between the wires—the lugs accurately sized.

Remember the Layne patented wire wrapped Screen has earned its leadership through performance.



Remember

You can make one trip into the hole do the job of two by using the Layne Tubing Set Packer.

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Room 1636
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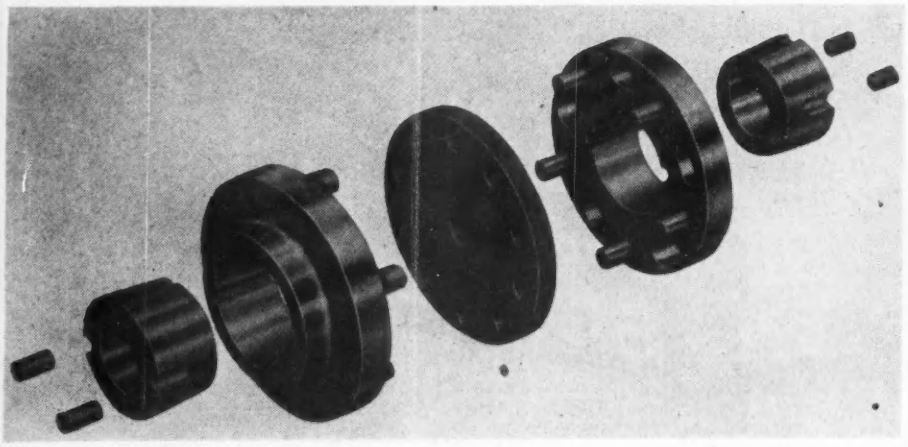
New York, N. Y.

General Office & Factory
8000 Market Street **Houston, Texas**

WEST COAST:
Layne & Bowler Corp.,
900 Santa Fe Ave.,
Los Angeles, Cal.



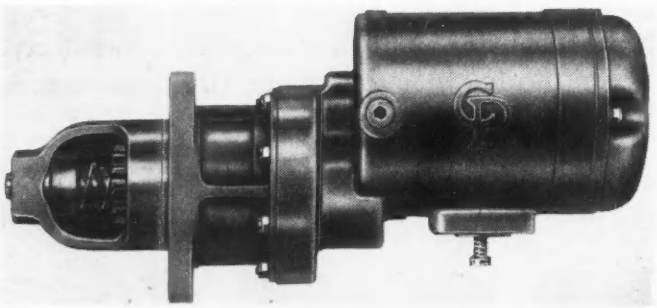
15—Flexible Coupling

A new pin-type flexible coupling incorporates the Taper-Lock bushing used successfully with V-Belt Sheaves. Use of this bushing not only insures fastening to shaft with firmness of a shrunk-on fit but also makes reboring unnecessary. The center disc is of oak-tanned sole leather providing flexibility, resiliency and strength.

Compact design occupies minimum space on shaft and there are no projecting parts. The center disc can be easily removed by loosening coupling flanges and sliding them apart on shafts. Large diameter centerless ground pins which are pressed into the flanges can be easily renewed. Coupling is machined all over to insure balance and true running. It is easy to install and remove and can be disconnected without moving coupled machines.

For additional information write the Dodge Manufacturing Corporation, Mishawaka, Ind.

16—Diesel Engine Starter



Natural gas is being used for starting high-speed diesel engines in the oil fields. A new "Air Starter" recently developed is a seven horsepower air motor with a Bendix starting drive. A unit 18 inches long and 5½ inches in diameter, it is mounted on any diesel by means of an SAE No. 2 flange.

The new Air Starter operates without any complexities, natural gas being used in place of air. The high-pressure gas is reduced to 125-150 pounds pressure and piped right into the motor. Diesels up to 600 cubic inch displacement are quickly and easily started.

For additional information write the Chicago Pneumatic Tool Company, 6 East 44th Street, New York 17.

17—Wire Line Jars

The new wire line jars make it possible to deliver a short jarring action to stuck tools when a limited amount of direct pull is put on the sand line. The tool is reset for repeated jarring by slacking off on the line. They are for use with bailers, sand pumps, swabs, or wire line fishing tools.

The assembly consists of a one-piece jar mandrel and jar head mounted in a tubular body with the jar mandrel sliding through a lifting head at the top of the tube. Spring fingers are mounted below the jar head. On the downward travel of the jar mandrel these spring fingers collapse inwardly to pass through a jar ring mounted on the inside of the tube. The angle on the top shoulder of the spring fingers and the underneath side of the jar ring is such that a considerable pull is required to collapse the spring fingers to permit upward movement of the jar mandrel.

When the jar is in its set position it will remain that way until the tools below the jars become stuck. The finger cluster resists upward movement of the jar mandrel until from five to seven feet of stretch have been put in the sand line. The load on the fingers is then sufficient to cause them to bend inwardly and allow for passage through the jar ring. The sand line being under tension is free to contract, thereby developing a sharp jarring action. The effective blow delivered is of course influenced by the amount of sinker bar, or stem, which is run above the jars. This can be varied from a weight of 50 pounds on the smallest size to 300 pounds for the largest size jar.

These jars are made in 1½ inches outside diameter size for measuring line (piano wire) use, 1¾, 2, 2½, 3 and 3½ inches for sand line or drilling line use. They can be adjusted to release and jar from as little as 100 pounds pull in the smallest sizes to 3500 pounds maximum pull for the largest size. The standard stroke is ten inches.

For additional information write The Cavins Company, 2853 Cherry Avenue, Long Beach, Calif.

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Simple in design, ruggedly built for heavy duty service. Gear ratio and throw of crank produce required speed with no strain. Heads and cranks of 100 CC and 15 CC machines are interchangeable. Meets A.S.T.M. *Standard Method D-96 and A.P.I. Code No. 25 requirements.* Ask for full details.

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—President, Independent Oil Company

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"For many years we have used your publication in our work and have relied on its excellent coverage to keep us informed concerning developments in the oil industry. The shift to the new monthly basis and the broadened scope of coverage gives the magazine an even greater value."—*Petroleum Economist*

"This new monthly WORLD OIL is okay! Well edited and full of information of interest to us. Best of luck to you."—*Executive*

"Your story on the drilling contracting situation was a comprehensive one, well written and done with a minimum of words. WORLD OIL is to be thanked for having brought it to the attention of the whole industry."

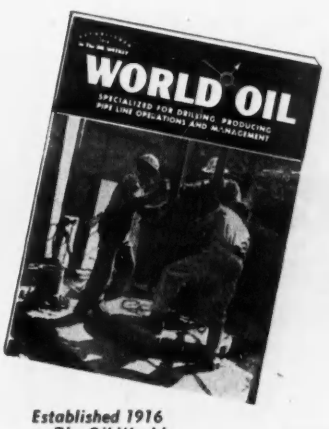
—Oil Well Drilling Contractor

"Congratulations to the editors on the new monthly WORLD OIL. The many well written and well presented articles make the magazine more valuable than ever before."—*Independent Operator*

Commendations like these are an inspiration to the editors in doing the type of editorial job that makes each issue of WORLD OIL welcome by operating and management men of authority in the drilling, producing and pipeline industry throughout the world.

WORLD OIL

The Gulf Publishing Company Publication edited for the drilling, producing and pipeline industry



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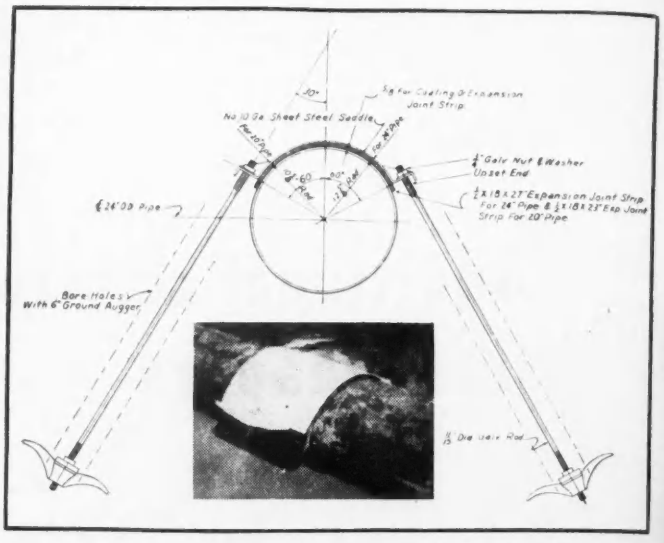
NEW EQUIPMENT
LITERATURE

18—Pipe Line Anchor



Designed to firmly anchor pipe lines in swampy areas, in ditches and to maintain alignment at bends either at the surface or beneath the ground is a new pipe line anchor. The complete assembly consists of a sturdy galvanized sheet-steel pipe saddle, two galvanized anchor rods, and two Grip-Tite positive-expanding anchors. The saddle is 18 inches long and covers a 120-degree arc on the pipe. Anchor rods are available in varying lengths, depending on the installation, and in diameters from 11/16- to 1¼-inch.

The Grip-Tite positive-expanding, thread-type anchor is made of certified malleable iron and is available in three sizes. The No. 201 anchor is installed in a six-inch hole and spreads to 16 inches in diameter. It has three wings affording 80 square inches of bearing surface and may be equipped with a ⅝-, ¾- or 1-inch rod. The No. 301 anchor fits into a nine-inch hole and spreads to 21 inches in diameter, and also has three wings. Bearing surface is 150 square inches. It can be fitted with a ¾-, 1-, or 1¼-inch rod. Anchor No. 101 consists of three wings and may be installed in a ten-inch hole. It may be equipped with only a 1¼-inch rod. Bearing surface is 215 square inches.

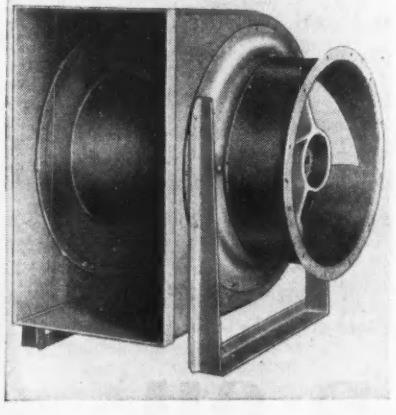
The pipe line anchor saddle provides a large bearing area, as complete protection to the pipe coating. A half-inch expansion joint pad is used to prevent damage to the coating and to aid in the uniform distribution of compressive stresses.

The complete anchor assembly is available for pipe lines in all sizes from 6⅝ to 31 inches in diameter.

For additional information write Grip-Tite Manufacturing Company, P. O. Box 45, Marshall, Texas.

19—Axiflo Fans

A new line of axial flow pressure fans is available in the straight-through type or the convertible elbow type, both furnished with either the three-bladed aluminum alloy wheel or eight-bladed steel wheel. Applications for these Axiflo fans include air conditioning, dust and fume removal, machinery cooling, mechanical draft for combustion, industrial drying and processing.



Designed for either vertical or horizontal operation, these Axiflo pressure fans have high mechanical and static efficiency combined with large volumetric capacity to perform effectively against resistance of wind and duct systems. Compact in design and sturdy in construction, the fans offer other special features such as less space and weight, high efficiency, straight air flow, and simplified mounting. The convertible elbow type with motor, belt and bearings located outside the air stream, readily accessible for inspection and maintenance, is ideal for high temperature service.

Sizes vary from 18 to 72 inches; static pressures from 0 to 3 inches, and displacement from 2000 to 115,000 cubic feet per minute.

For information write Westinghouse Electric Corporation, Sturtevant Division, Hyde Park, Mass.

20—Electric Amplidyne

The new electric amplidyne is a high-capacity amplifier useful in many types of motor control where precise regulation of current, voltage and speed are necessary. It consists of a high-gain balanced DC electronic amplifier and a motor amplidyne.

Designed for use as a regulated adjustable-voltage power supply for d-c motors up to 1½ horsepower and as a regulated exciter for larger adjustable-voltage drives up to 200 hp, the equipment has an output of 1½ kilowatt, 250 volts. It is arranged for use on either a 220- or 440-volt, 3-phase, 60-cycle power supply.

The electronic amplidyne makes possible a speed range of 20 to 1 or greater. It maintains speed closely at any set-

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BUTLER BUILT Bolted Tanks, Walkways and Stairways are Quick to Erect For Long Service Life

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ting, regardless of load conditions. It assures smooth, rapid acceleration and reduces starting shock on the driven machine by means of current limit control of acceleration and stalled current.

Quick stopping without undue stress

to motor or driven load is provided by suicide braking utilizing current limited regeneration. The equipment satisfactorily maintains speed on overahuling loads where the motor is required to absorb power and act as a brake during part of the loading cycle.

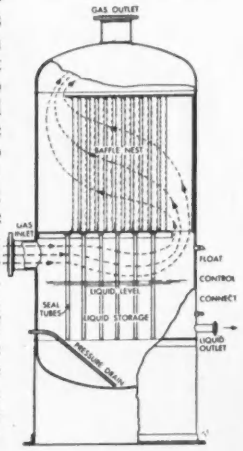
Design features include a completely balanced amplifier which is insensitive to line voltage changes; an industrial electronic amplifier with hinged panel which provides easy access to all parts and connections; a circuit which is easily adjusted for various operating conditions, and a locking device which maintains settings once the circuit has been adjusted.

For additional information write Motors Division, General Electric Company, Schenectady 5, N. Y.

21—Gas Separator

A new principle of baffle design for complete mist separation has been incorporated in the Screenless Mist-D-Fier.

This improved gas separator embodies a series of curved welded baffles installed in staggered rows. Gas passing between these baffles must turn sharply to gain the staggered openings of the next row, and so on, through 11 rows. The mist particles are thrown out of the flow by centrifugal action and impinge on the curved surface of the baffle where they agglomerate into a film. Gas impact causes this film to creep along the curved surface of the baffle, forcing the liquid into vertical slots where it trickles down to the bottom of the baffle into seal tubes and flows down to the bottom trap. The clean gas is directed upward to the outlet at the top of the Mist-D-Fier.



The device removes all traces of crude oil from natural gas entering an absorption plant; also oil mist and water from gas leaving the plant. It can be used as a separator between the dephlegmator and the condenser or on the end of the condenser after the accumulator. Other uses are as a separator on the inlet gas to a compressor plant; as a knockout, as a separtor for eliminating lubricating oil from any gaseous product, or as a live steam separator for maintaining dry steam.

For additional information write J. A. Campbell Company, 645 East Wardlow Road, Long Beach 7, Calif.

22—Helium Cryostat

Research laboratories generally can now undertake work at temperatures close to absolute zero as a result of the availability of the Collins Helium Cryostat, a relatively simple device which liquefies helium and can maintain any temperature down to 2° Kelvin, or 456°

below zero on the Fahrenheit scale.

The cold space of the Collins Helium Cryostat and part of the refrigerating equipment is contained within a steel vacuum jacket 12 inches in diameter and about five feet tall, which is housed within a cabinet measuring about 3 feet by 2. Other equipment includes a ten-horsepower compressor and a low-pressure gas holder. The complete unit weighs about 2800 pounds and occupies less than 50 square feet of floor space. Helium is the only refrigerant used. Liquid helium, or other liquefied gas, can be removed from the equipment.

Its novel technical features include a heat exchanger which cools the compressed helium from room temperature to liquid-helium temperature and yet weighs only a few pounds, and a piston and cylinder expansion engine originally developed for use in oxygen generation. This engine uses a flexible connecting rod in tension, which aligns a specially hardened, closely fitting piston within the cylinder and permits it to operate at extremely low temperatures without lubrication.

For additional information write A. D. Little, Inc., 30 Memorial Drive, Cambridge 42, Mass.

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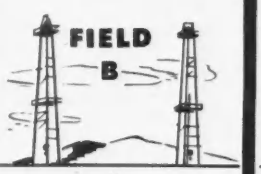
Another Example of Increased Production with BLACK MAGIC OIL BASE DRILLING FLUID

COMPARE THESE 8 OFFSETTING WELLS IN 4 SEPARATE FIELDS. Each well completed with Black Magic is compared with an offset well completed with a conventional water base mud. In each comparison the factors governing production closely parallel one another—such as chokes, permeability, pressures, etc. Only in *production figures* do the wells lack similarity. *Black Magic is the deciding factor here.*



	FIELD A		FIELD B		FIELD C		FIELD D	
	BLACK MAGIC	WATER BASE	**BLACK MAGIC**	WATER BASE	**BLACK MAGIC**	WATER BASE	**BLACK MAGIC**	WATER BASE
Initial Production — Bbls./Day	**1563**	558	**369**	330	**1575**	1030	**374**	88
Productivity Index	**1.42**	0.144	**250.**	60.	**5.73**	1.22	**7.5**	0.98
Producing Zone Interval	**110′**	90′	**178′**	170′	**270′**	260′	**35′**	31′
Permeability, Approx.	**60m.d.**	60m.d.	**600m.d.**	600m.d.	**300m.d.**	300m.d.	**2400m.d.**	2400m.d.
Bottom Hole Pressure, psi	**3635**	3580	**2250**	2370	**1834**	1450	**136**	110
Later Production Bbls./Day (Comparable Restricted Chokes)	**311**	125	**350**	284	**525**	282	**423**	65

THESE ARE NOT UNUSUAL EXAMPLES. In almost every instance where data is available, wells drilled with Black Magic show greater production, not only at the time of completion but many months later, and production curves at the end of two and three year periods are on the average even more amazing.

Water in the producing zone restricts the free flow of crude oil, lessening the ultimate recovery of oil from the well. This is commonly referred to as "water blocking" or "mudding off." By capillary action and hydrous swelling of the formation, water particles actually seal up minute crevices in oil sands and even under extreme pressures the water is never completely dislodged.

Black Magic has a zero filtrate loss, forms only a paper thin mud cake, which is completely taken off by crude oil, eliminating blocking off the pay section.

In addition, cement, salt, anhydrite, gypsum and limestone will not affect it. No chemicals are needed to maintain the properties of Black Magic. Core recovery is higher than with any other drilling fluid and accurate values are obtained. Black Magic lubricates bit bearings, allows longer bit time on bottom, keeps a hole "to gauge" and eliminates conditions causing stuck pipe. Black Magic may be regenerated and used over and over again. When properly used it is one of the most economical commodities in the entire drilling operation.

Write for "Oil Base Drilling Fluids"— an informative paper delivered at 75th annual meeting of A.I.M.E.; and Black Magic Catalog.

Black Magic is not to be confused with any other type of oil base drilling fluid and is manufactured, distributed and serviced by Oil Base, Inc., an entirely independent company.

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NEW EQUIPMENT LITERATURE

23—Streamlined Rotaries

Devoted to describing and illustrating streamlined rotaries for oil field drilling is a 12-page, three-color bulletin, R-47. The complete line of Ideco Streamlined Rotaries are listed, describing in detail the engineering features and specifications of each. An "exploded" view graphically illustrates the construction of the rotaries. Bearings, gears and the complete oil bath system are shown in green tint as contrast to the remainder of the unit for a clear understanding of this feature.

The hydro-rotary unit with internal combustion engine drive is also briefly discussed and pictured. Specifications and illustrations are presented on the Ideco roller kelly drives.

International Derrick & Equipment Company, Ideco Building, 1315 Pacific Avenue, Dallas.

24—Type "S" Diesel Engines

A new two-color folder, Form 10311, describes the new Type SS turbocharged Diesel engines. The front cover clearly illustrates the fully enclosed engine, emphasizing its clean, smooth lines, the accessibility of filters and controls. The inside spread is devoted to horsepower ratings, fuel consumption curves and the listing of new features and improvements. An excellent comparison of the space requirements of the turbocharged SS and an unsupercharged engine is closely presented. The back page contains a table and diagram listing ratings and dimensions.

Ingersoll-Rand, 11 Broadway, New York 4.

25—Well Services

An eight-page brochure describes the construction and uses of the All-Purpose Johnston Gun Perforator and tells how it functions in combination perforating and formation testing operations.

Another publication contains a comprehensive treatise on the Johnston Formation Tester. It explains the engineering features of the tester and accessory equipment, and presents detailed instruction and illustrations on all phases of formation testing.

M. O. Johnston Oil Field Service Company, 3035 Andrita Street, Los Angeles 41.

26—Oil Hose

Oil hose for cargo handling is described as one of the most highly specialized products of the rubber industry, since the service conditions in transporting oils and gasolines are extremely severe. Types described include dock loading, sea loading and hose for barge service, as well as the fittings which go with them. Data on each type is included.

Published by The B. F. Goodrich Company, Akron, Ohio.

27—Oil Field Swivel

Bulletin 346, eight pages, 8½ x 11 inches, describes and illustrates the Ideal Type D Swivel, a medium swivel rated at 150 tons at 150 revolutions per minute. The bulletin includes specifications, life expectancy chart showing the influence of loading and speed on the performance of the main bearing, and a description of construction, design, and materials in the D-swivel and accessories, with "exploded" and cutaway views of parts and assembly.

The National Supply Company, P. O. Box 899A, Toledo 1.

28—Oil Country Equipment

Book 2080-A, "Link-Belt Oil Country Equipment," contains 36 pages of descriptive material and illustrations to present more than a dozen different items of oil field equipment. Photographs, drawings, charts and diagrams are used to illustrate roller chain, sprockets, mud screens, speed reducers, speed increasers, chain drives, flexible couplings, ball and roller bearing units, shovels, draglines and cranes. Specifications and cross-sectional drawings show every feature of the oil field roller chains and sprockets. Phantom views and actual installation photographs depict construction and application of speed reducers. Mud screens for shallow, medium and deep oil well drilling are described and pictured.

Link-Belt Company, 519 N. Holmes, Indianapolis.

29—Protective Coatings

A 12-page catalog giving complete details on the chemical and physical properties, application instructions, and other pertinent data on protective coatings is now available. Catalogs for ten major industries give full technical information pertaining to each industry.

Amercoat Division, American Pipe and Construction Co., P. O. Box 3428, Terminal Annex 54, Calif.

30—Pressure Control

Illustrations and operating details on the installation and use of the Otis Pressure-Lock Packer are contained in a new four-page, two-color folder.

Introducing the new Otis Surface Safety Valve is a four-page, three-color brochure which describes and illustrates the safety features of the new valve.

Otis Pressure Control, Inc., 6600 Denton Road, Dallas.

31—Pump

Allis-Chalmers' automatic, self-priming pump equipped with a new type automatic spring valve which is said to give faster, smoother transition from priming or vacuum pumping to straight centrifugal action, is described in an eight-page illustrated bulletin.

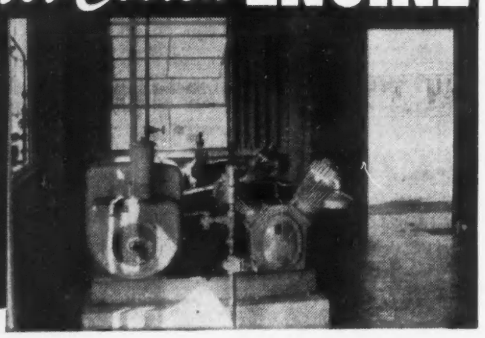
According to the bulletin, the pump's portability, rapid installation, quick priming features, and non-clog design of its open impeller types, make it a valuable tool in almost every industry.

The pump's simple design, which is graphically portrayed, makes for easy maintenance of its vital parts.

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis.

WISCONSIN *Air-Cooled* ENGINE

On the Job at the New Lake St. John Gas-Cycling and Pressure Maintenance Project



Included in the modern equipment employed by the California Company at the new Lake St. John Gas-Cycling and Pressure Maintenance Plant in Louisiana is this Wisconsin Model VE-4, V-type, 4-cylinder air-cooled power unit, driving a compressor. Here, in this new eastern Louisiana field where gas-cycling and condensate production, pressure maintenance and flush oil production are all combined, is located one of the most modern plants built to date. It is only logical, therefore, that the most efficient and dependable power equipment should be specified, in keeping with the high standards set by the designing and operating engineers.

Because Wisconsin Heavy-Duty Air-Cooled Engines deliver the maximum in Hp. Hours of on-the-job service, they can be depended upon to fulfill their power obligations even beyond the top limits of optimistic expectations. You can't go wrong when you specify: Wisconsin Air-Cooled Engines for any power job within a 2 to 30 hp. range.

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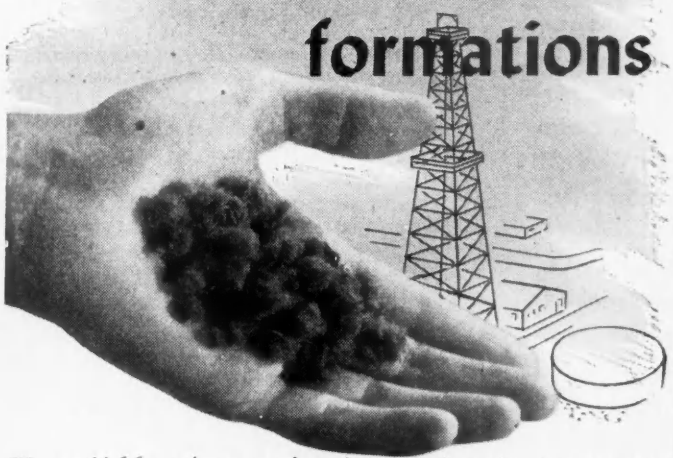
Oil field distributors for Wisconsin Engines and all types of utility units.

the modern way to deal with thief formations



When a thief formation causes lost circulation, be ready—the sure way! Operators are successfully using basic fibrous raw materials, manufactured by Wood Conversion Company, to bridge fissures and to seal off porous areas in the formation wall. These materials, widely known under the trade name K-25 Industrial Fiber (shipped in bales), can be mixed and held in reserve—ready for use whenever needed. The chemically treated fibers of clean, new, coniferous wood form a lasting mat, providing a dense seal—fibers stay suspended in the mud until deposited. K-25 Industrial Fiber is impervious to rot and decay—is excellent when used as a mud conditioner. For full information and samples write Wood Conversion Company, Dept. **201-18**, First National Bank Bldg., St. Paul 1, Minnesota.

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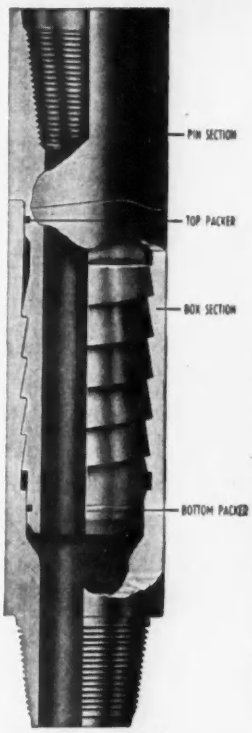

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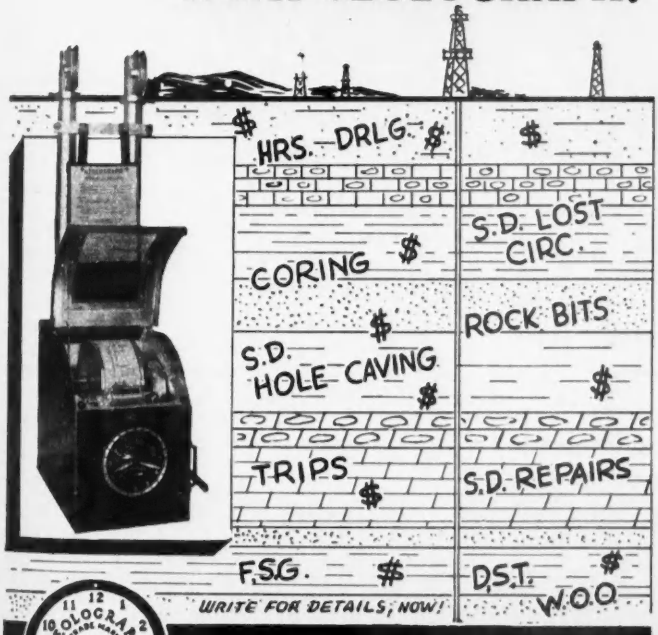

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Letters TO THE EDITOR

World Oil invites letters to this column on any subject of interest to the oil industry.

Fire Walls ARE Necessary

Sirs:

I was very much interested in Anthony Gibbon's article, "Are Lease Tank Battery Fire Walls Necessary?" which appeared in World Oil for November, 1947.

I am, of course, very much in disagreement with you. I will admit that you may find a specific or isolated condition which would meet your recommendation, but in my 17 years' experience in oil and gas fields I have known many instances where a $200 firewall saved a $50,000 tank battery and contents from loss by fire, not to mention the times when firewalls have prevented property damage claims and loss when oil overflowed.

For details of fire losses resulting from absence of firewalls as well as the benefits and protection afforded by firewalls, I refer you to the National Fire Protection Association of Boston, Mass., who can quote you thousands of case histories.

I would like to remind you that although firewalls may be a "carry over from early wooden tank days," there is no mistaken idea about the hazards involved. The lease switchers of today are as subject to mental errors as they were 50 years ago and they still overflow tanks, carry matches, smoke, and commit the same unsafe acts as their forefathers, and the lightning, wind, and elements of nature are just as powerful as they ever were.

In brief, I feel that your $2000 protection for a period of 15 years on a tank battery and contents that may see as much as $5 million worth of oil pass through its tanks is cheap insurance.

In reply to your listed disadvantages of firewalls, I deny that *properly* installed tanks and firewalls prevent drainage or produce external corrosion.

Secondly, there is a distinct advantage when trash or weeds can be collected or trapped. An efficient farm boss has the responsibility of keeping his battery clean.

Thirdly, there is an advantage when spilled oil can be collected and recovered instead of lost. As to poisonous gases, you are aware that in *any* area where H_2S or such is present, safety rules require masks —firewalls or no firewalls.

Fourth, they are definitely not a hindrance to "good-housekeeping." I cannot imagine the mess and spread of muck that would result if a tank were cleaned without the services of some sort of retaining wall. An overflow without firewalls would certainly spread and cover a *larger* area and naturally require more clean up.

Fifth, the use of proper stairways over obstacles is definitely not a hazard. I request you to quote a single safety authority in disagreement. Proper stairways provide a safer walking surface and area than natural earth.

Finally, there is a definite guarding value in a firewall that deters trespassers from entering the battery either by accident or for the purpose of theft. I know of one instance where a runaway truck

would have crashed into a full tank battery had it not been for the firewall.

Of course, I realize that your article refers specifically to lease tank batteries, but the same principles apply to refinery, tank farm, and gasoline plant storage. (Or do you confine your beliefs just to lease tanks?)

Your article has caused some doubt and confusion in the minds of certain oil and gas company executives and there is some danger of a trend toward abolishment of this protection. Such a condition would produce excessive insurance rates and might set the stage for another disaster such as Texas City.

As chairman of the engineering committee of the petroleum section of the National Safety Council as well as a safety committee member of the American Petroleum Institute, I can assure you that your article is going to get "kicked" around.

In conclusion, I wish to thank you for bringing this question to a climax with your interesting and debatable article.

DON ATTAWAY,
Safety Engineer, Shreveport.

Flowers that Bloom in December

When you announced the proposed discontinuance of *The Oil Weekly* and in its place a publication of quite a different type and character of contents, to be known as WORLD OIL, I thought that I was going to be disappointed in the new publication as compared with *The Oil Weekly*. However, it has proven to be quite the contrary.

Last evening I spent reading the December issue of WORLD OIL and when retiring time came I hated to lay it down. From cover to cover, including "The Changing Panorama," "Monthly News Analysis," "Looking Ahead" and the many well-prepared and well-illustrated technical articles, the issue is extremely interesting and valuable reading.

I know that you must wonder about the reaction of your subscribers to the change and I feel that I should tell you the view of one who was for a long time a reader of *The Oil Weekly*.

L. H. JONAS,
Oil Operator, Centralia, Ill.

Drilling Contractors' Plight

The figures which you have used are substantially correct and the remarks which you have made are certainly pertinent and reflect the condition of the contracting industry. The oil industry should not permit the drilling contracting industry to deteriorate. It is not healthy for one segment of the oil industry to become stagnant and deteriorate, especially at a time when the industry as a whole is making more profit than it has ever made before in its history.

I thank you for having brought this matter to the attention of the whole industry.

ARCH H. ROWAN,
Rowan Drilling Company,
Fort Worth

This Foreign Aid Monkey Business

It seems well established that there are hungry men, women and children in Europe. Without too much reference to whose fault it is, or to how many bumper industrial and agricultural crops could have been raised in Europe since the war, we can't let people starve.

All of which is something to take in our stride. People are hungry. We intend to feed them.

So what? So the president and the Commies and the C. I. O. and the old lean, hungry pack from the O. P. A. and the W. P. B. and the X. Y. Z. see golden opportunity. We must at once regiment everything. We must have bureaus and price controls and rationing and managed economy. We must get organized quickly. Broad powers must be granted at once. There is no time to lose!

All of which has absolutely nothing to do with feeding hungry people in Europe, but most of us are too busy with normal, typically American things to notice. As the Wall Street Journal says, "The Plot Sickens."

In the history of the rise and fall of other great nations there have been situations like this.

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Texas AIME Members Meet With Student Affiliates

More than 300 AIME members, guests and students conferred on the campus of Texas A & M College at Bryan, Texas, December 4-5, in a joint meeting of five Texas sections of AIME and two student society affiliates. A & M acted as host, with A. B. Stevens, professor of petroleum engineering as chairman of the program committee. This is the second such meeting. The first was held at The University of Texas in Austin under the sponsorship of the University's Petroleum Engineering Department.

Highlight of these annual meetings is the contest between outstanding petroleum engineering students, one from A & M and one from Texas University, who present technical papers. Winner of these contests is awarded a cash prize by the Gulf Coast Section. The 1947 award was won by J. L. Hargrove, senior engineering student at the University who was presented with a cash prize by Harold Decker, chairman of the Gulf Coast Section. Judges for the student contest were R. S. Christie, Amerada Petroleum Corporation, Fort Worth; R. S. Dewey, Humble Oil & Refining Company, Midland, Texas; and I. W. Alcorn, The Pure Oil Company, Houston.

Culminating the meeting was a banquet presided over by A. O. Hamon, president of Petroleum Engineering Club, Texas A & M. Toastmaster Henry Gruy, DeGolyer & MacNaughton, Dallas, introduced the guest speaker, Col. T. H. Barton, chairman of the Board, Lion Oil Company, El Dorado, Ark. Colonel Barton's address was directed to the student engineers, urging them to take full advantage of the educational opportunities available to them. "To maintain leadership among technical industries, the oil industry will need more highly trained men in its ranks."

Digests of some of the papers available follow:

Corrosion Insurance Through Plastic Insulation of Pipe Fittings

By J. A. CLAY, JR., Service Engineers, Inc., Fort Worth.

Corrosion in the oil industry is costing $10 million each month for repairs and replacements. One source of trouble is that of stray currents. Corrosion due to these usually will be localized over a very small area. Chemical corrosion is accelerated by stray currents from two to ten fold. These currents are usually small in magnitude, less than one ampere, and may vary according to the existing conditions at time of measurement. The terrain in which flow lines and pipe lines lay play an important part in the magnitude and duration of currents.

The stray currents can be stopped by insulation made from a laminated, phenolic resin, fabric base plastic. Ring-type gasket insulators of this material up to eight-inch pipe size have withstood API test pressures of twice the working pressure. These tests have been taken as high as 10,000 pounds per square inch. To completely insulate flange unions, bolt sleeves and washers are used in addition to the plastic gasket. It is estimated that the total cost of an insulating program will be less than $15 per well, and in many cases as little as $5 per well.

Drilling Mud Control in Southwest Texas

By E. H. LANCASTER, JR., and M. E. MITCHELL, JR., Humble Oil & Refining Company, Corpus Christi, Texas.

A moderate alkaline-tannate-bentonite treatment resulting in an ultimate filtration rate of ten cubic centimeters or less (API test) has been found effective for drilling and completing routine field wells requiring relatively short drilling time. Pressure information from producing reservoirs and from drill-stem tests in other zones determine the mud weighting program. Mud viscosities of 45 seconds (Marsh) are sufficient to remove cuttings from the average well with the pumps in general use. On field wells requiring more than 30 days drilling time, an alkaline-tannate-lime-bentonite treatment has been effective with a substantial reduction in chemical costs. Particular advantage has been shown on heavily weighted muds and those with abnormal flow line temperatures.

The chemical treatment employed on wildcat wells follows, for the most part, the program used on field wells, depending on depth and duration of operations. Wildcat mud programs are planned from information available from various geologic and operational sources, taking into consideration the possibility of encountering mud problems of a special nature in the wildcat area.

An analysis and recommended treatment are presented on several special mud problems which have been encountered in the area in the past. Problems discussed are lost circulation, blowouts, sloughing shale, excessive chloride contamination, sulfate contamination, and prevention and correction of cement contamination.

Natural Gas Reserves in Texas

By JACK CRICHTON, DeGolyer & MacNaughton, Dallas.

Knowledge and understanding of the natural gas reserves contained in Texas are important to individuals and organizations obtaining gas from Texas for various purposes. Conflicting reports on the gas reserve situation in Texas result in confusion among these groups.

Natural gas is found in the reservoir as: (1) non-associated gas, that not in contact with crude oil in the reservoir; (2) associated gas, free gas in contact with crude oil in the reservoir; and (3) dissolved gas, in solution in crude

Dallas Geophysical Society Organized

Eighty-eight members attended the first monthly meeting of the Dallas Geophysical Society, organized in October. Officers named were A. E. McKay, The Atlantic Refining Company, president; W. W. Newton, The Geotechnical Corporation, first vice president; C. J. Donnally, Western Geophysical Company, second vice president; and D. Ray Dobyns, Magnolia Petroleum Company, secretary-treasurer. Paul E. Nash presented a paper on "A Resume of Efforts to Promulgate Rules and Regulations Governing Offshore Seismic Exploration on the Texas Gulf Coast"; and Kenneth Burg presented a paper on "Seismic Operations and Offshore Operations on the California Coast."

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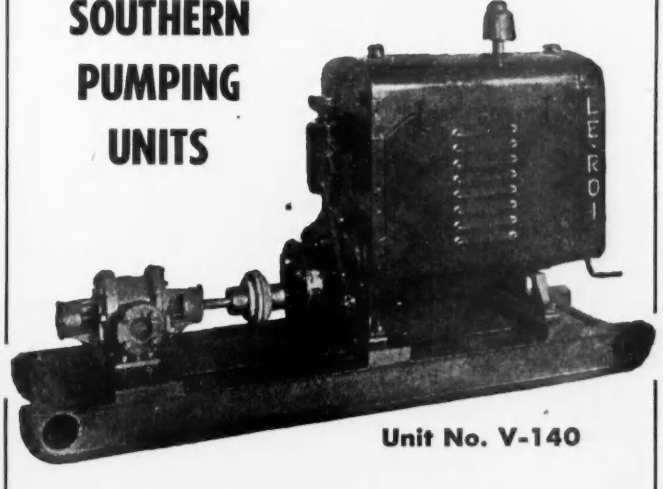

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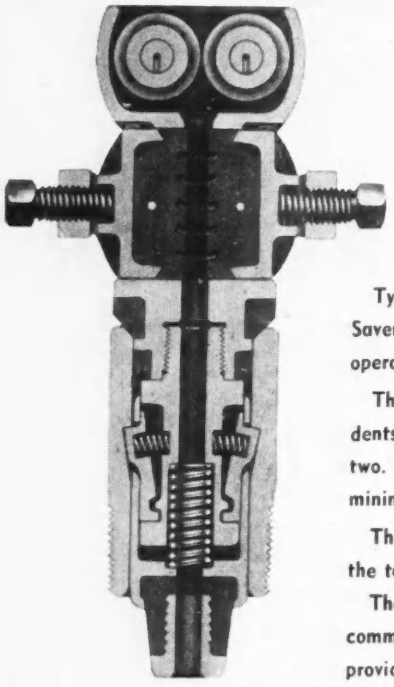
oil in the reservoir. Volume-temperature-pressure methods applied to an abandonment pressure or recovery factor are used to determine reserves in the first group. The estimation of associated and dissolved gas reserves is based on the volumetric method. Dissolved gas reserves are estimated by considering the original volume of stock tank oil in place multiplied by the original solution gas-oil ratio and applying a recovery factor. With sufficient data, experience, and judgment, gas reserves can be estimated with a reasonable degree of accuracy.

As of January 1, 1947, it was estimated the recoverable gas reserves in Texas to be about 85½ trillion cubic feet at a base pressure of 16.4 pounds per square inch and at 60° F. The recoverable reserve of the U. S. as of same date is about 151¼ trillion cubic feet. The estimated known gas reserves increase yearly due to new discoveries, extensions, and deeper pays. Large gas transmission lines planned and now in use plus the many processing uses of gas make it more profitable to produce. Our natural gas, like other minerals, is a source of wealth only when it is exploited and made available to the country in usable form.

For Swabbing Operations



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Type 3AR King Wire Line Stripper (often called "Oil Saver") is the ideal tool to use in connection with swabbing operations.

The positive latch and sure release insure against accidents and eliminate the possibility of jerking a wire line in two. The non-sparking materials used in its construction, minimize the fire hazard.

The packing is inserted from the sides of the tool and the tool can be repacked while the line is in the hole.

The roller line guides center the line and outlast the more commonly used bushing many times. Grease nipples are provided to lubricate the guide rollers. Convenient hand holds contribute to easy handling of the tool. *This tool is constantly coming into greater use.* A trial is convincing.

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The Type 4AR Stripper is similar to the Type 3AR, except it is a little larger. It is commonly used in connection with the Type 4C King Circulating Head. It can be, and sometimes is used with other makes of circulating heads.

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See 1946-47 Composite Catalog (Pages 1915 to 1922) for detailed description of other King Tools.

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Cased-Hole Vs. Open-Hole Well Completions in West Texas-New Mexico Area

By WARREN J. JACKSON and ROBERT M. RUTLEDGE, JR., Lane-Wells Company

In measuring the efficiency of cased-hole and open-hole completions, maximum efficient performance of the reservoir and the resulting economy should be the basis of comparison. For areas in which the reservoirs do not produce from fractures, cased-hole well completions followed by gun-perforation offer the best solution at the present time. Producing formations in the area considered are limestones, dolomites or dolomitic limestones with low and non-uniform permeabilities. It is the consensus that a majority of the reservoirs are composed of a series of separate reservoirs of different characteristics.

To obtain more uniform flow into the well bore from the various producing layers, the casing should be perforated selectively opposite each known oil-productive zone. Perforations can be placed according to the average productivity of each layer. Considerable perforating costs are thus eliminated. In comparing cased and open hole wells in a West Texas field, a noticeable difference is observed between the productivity indices of the cased and open-hole wells where less than six perforations per foot were used.

On the basis of information available the following conclusions are submitted:

1. Cased-hole methods of completion in suitable limestone or dolomitic reservoirs should result in more efficient use of reservoir energy.

2. The workover expenditures for exclusion of gas or water should be less.

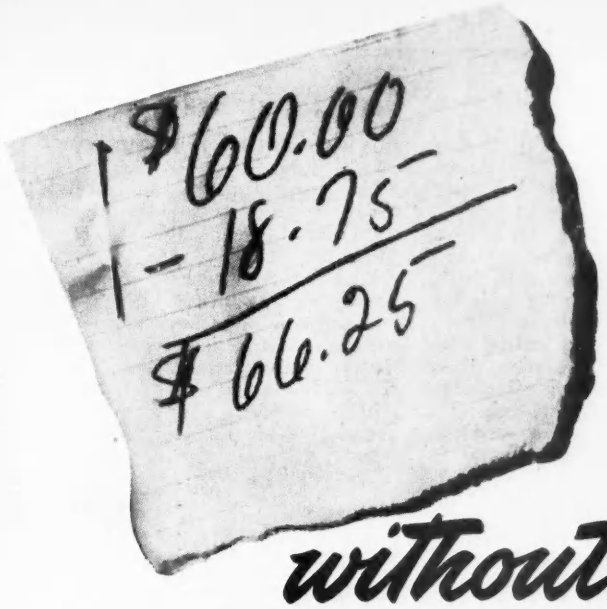
3. Selectively gun-perforating known producing horizons on a basis of indicated productivity should facilitate a more effective treatment of the individual zones with acid, and also result in a more uniform flow into the well bore.

Vertical Segregation of Zones With Plastics in Oil and Gas Wells

By C. E. MANGOLD, Dowell Incorporated, Tulsa.

The versatility of plastics has made them popular substitutes for many materials. Because of their inherent properties, they appear to be an answer to the problem of vertical segregation of formations in the well bore.

Plastics used in oil and gas wells are thermo-setting liquids with a specific gravity of about 1.2. Their change from a liquid to a solid is dependent on the formation temperature, and the setting time is controlled by a catalyst. These materials are dark brown in color, are immiscible in brine, water and oil, and will penetrate formations of low permeability under normal differential pressures without filtering out. Two types are employed: those used for consolidating sands and remain permeable, and those which retain no permeability. The degree of maximum penetration of the plastic into a formation can be controlled by the addition of certain inert



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You start with $60, representing someone's weekly take-home pay. You deduct $18.75 for the purchase of a U.S. Savings Bond. That leaves $41.25. But $41.25 isn't what the worker takes home. He takes home $41.25 *plus a $25 Savings Bond.* Total (assuming he holds the Bond till maturity): *$66.25.*

WHAT 19,000 COMPANIES HAVE LEARNED

In the 19,000 companies that are operating the Payroll Savings Plan for the regular purchase of Savings Bonds, employees have been more contented in their jobs—absenteeism has decreased—even accidents have been fewer!

Those are the "company" benefits the Plan provides, in addition to extra security for individual employees.

But the Plan has other, far-reaching benefits of basic importance to both your business and the national economy...

SPREADING THE NATIONAL DEBT HELPS SECURE YOUR FUTURE

The future of your business is closely dependent upon the future economy of your country. To a major extent, that future depends upon management of the public debt. Distribution of the debt as widely as possible among the people of the nation will result in the greatest good for all.

How that works is clearly and briefly described in the free brochure shown at the right. Request your copy—*today*—from your State Director of the U. S. Treasury Department's Savings Bonds Division.

ACTION BY TOP MANAGEMENT NEEDED

The benefits of regular Bond-buying are as important today as ever—but war-time emotional appeals are gone. Sponsorship of the Payroll Savings Plan by a responsible executive in your company is necessary to keep its benefits *advertised to your employees.*

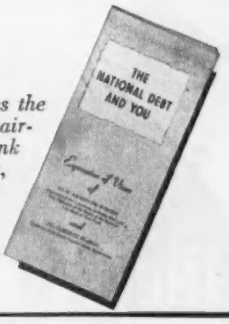
Banks don't sell Savings Bonds on the "installment plan"—which is the way most workers prefer to buy them. *Such workers want and need the Payroll Savings Plan.*

Those are the reasons why it's important to make sure that the Plan is adequately maintained in your company.

The State Director will gladly give you any assistance you wish.

"The National Debt and You,"

a 12-page pocket-size brochure, expresses the views of W. Randolph Burgess, Vice Chairman of the Board of the National City Bank of New York—and of Clarence Francis, Chairman of the Board, General Foods Corporation. Be sure to get your copy from the Treasury Department's State Director, Savings Bonds Division.

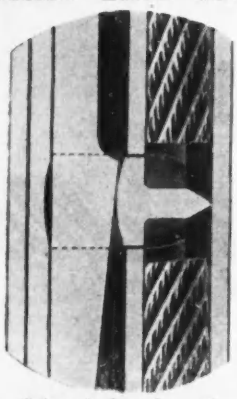


The Treasury Department acknowledges with appreciation the publication of this message by

WORLD OIL

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council

IF you ever need to get loose from a STUCK SAND LINE,
IT CAN BE DONE
with the KINLEY
SAND LINE CUTTING TOOL



Enlarged drawing of section of tool inside tubing, showing tapered wedge forcing knife thru wire line.

Cuts any size wire line up to 11/16" in any size pipe as small as 2" tubing. It cuts the stuck line at the top of the rope socket, thus saving the line as well as the cost of a fishing job.

Complete details will gladly be sent on request.

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Day or Night
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Night—K. 3-3649

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solids of governed particle size and specific gravity.

The most common method of applying plastics is that employing a dump bailer. The tubing displacement and bradenhead squeeze is the most simple procedure used where low formation pressures exist, but lack of control make it undesirable. Tubing squeeze with drillable packer is one of the more popular methods. Many oil operators prefer to squeeze with tubing using a retrievable packer. Setting blank liners with plastic for the purpose of shutting off excess gas and water has been successful. The use of plastics as a cementing medium is performed in the same fashion as if cement were used.

Kansas-Oklahoma Oil, Gas Group Elects W. T. Payne

William T. Payne, president of Big Chief Drilling Company, Oklahoma City, was elected president of the Kansas-Oklahoma Division, Mid-Continent Oil & Gas Association, succeeding F. M. Porter, who declined a fourth term. All other officers were reelected as follows: Lloyd G. Owen, first vice president; A. W. Ambrose, vice president for northern Oklahoma; Lloyd Noble, vice president for southern Oklahoma; W. R. Wallace, vice president for western Oklahoma; Carl Weiner, vice president for eastern Kansas; H. E. Zoller, vice president for western Kansas; Clarel B. Mapes, secretary-treasurer.

Life memberships in the association were voted to Ralph R. Roark, retired vice president of Shell Oil Company, Inc.; A. J. Wells, retired tax attorney, The Carter Oil Company; and C. T. Plake, retired tax attorney, Gulf Oil Corporation.

N. M. Baird Named President Of New Mexico Association

Niven M. Baird of American Republics Corporation was elected president of the New Mexico Oil & Gas Association December 3 at Artesia. Baird, who succeeds Van S. Welch, has been a member of the executive committee since 1945.

The association unanimously reelected the executive committee, composed of Baird, Welch, Harry Leonard, D. D. Bodie, F. J. Danglade, Emery Carper, R. L. Hendrickson, J. N. Dunlavey, and John M. Kelly. The executive committee reelected Carper vice president; Leonard, treasurer; and Art McQuiddy, executive secretary.

Major General Patrick J. Hurley discussed free enterprise and the oil industry.

IPAA Group Elects

J. Garfield Buell, independent Oklahoma oil operator of Tulsa, was elected vice president for eastern Oklahoma of the Independent Petroleum Association of America. C. E. Buchner, executive manager of the Association and a member of the executive committee, was reelected, and N. T. Gilbert, Tulsa, was reelected Association treasurer. Doyle Cotton of Enid and Fay Anderson and G. H. Blankenship of Tulsa, were elected directors for northern Oklahoma.

Boyd, Littell See New Uses For Radio in Oil Industry

Widespread use of radio in practically every phase of petroleum operation was forecast by President William R. Boyd, Jr., of the American Petroleum Institute in announcing the formation of a new Central Committee on Radio Facilities within the API Division of Transportation.

F. W. Littell

The Federal Communications Commission, Boyd said, has listened sympathetically to the request of the industry for the creation of a radio service governing radio stations used in petroleum industry production and pipe line operations under the pending Industrial Radio Service.

Meantime, a Radio Technical Commission for Marine Services is in process of formation, under which petroleum tankers and inland waterway barges will be given radio coverage.

The new committee will be headed by F. W. Littell, Shell Pipe Line Corporation, Houston. Secretary is Joseph E. Keller, National Petroleum Association, Washington, D. C. The vice chairman, J. A. Polhemus, Standard Oil Company of California, San Francisco, is also a chairman of a temporary committee on membership, which will select men within the industry familiar with the new uses of radio for membership.

The new committee, according to Boyd, is the outgrowth of activities of the Petroleum Industry Electrical Association, which as early as 1943 sought channels for radio communication on pipe lines. Last year, T. E. Swigart, Shell Pipe Line Corporation, Houston, suggested that the enlarging interest of the industry in radio could best be served by an API committee. This was approved by the Division of Transportation and the Board of Directors and a temporary committee was selected. That has now been replaced by a permanent committee to work with government agencies in formulating a radio framework for all phases of petroleum operation.

New Uses Ahead

According to Littell, the petroleum industry has used radio successfully for the past 20 years in geophysical exploration and has used available ship-to-shore radio-telephone service for drilling and production operations offshore in the Gulf of Mexico. Perfection of frequency modulation, however, has opened new vistas for widespread radio usage.

"Practically every division or branch of the petroleum industry," Littell said, "can well be served by one or more adaptations of radio to effect economies in operation, increase safety or raise efficiency. Radio may, perhaps, provide new methods of processing oil to supplement

can you identify

this oil product?

Next time you put a nickel in a juke box, remember you're giving an oil product a whirl. Yes—your favorite phonograph record is likely to be made from asphalt, an oil derivative.

can you identify

good ROPE?

Worth remembering is this name for good rope: NEW BEDFORD. Accepted among oil men for its long superior service. The next time you order rope, specify New Bedford. Meanwhile, take good care of the New Bedford rope you have on hand.

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End wrench for pipe in coils or on flat surfaces.

● *For your worker*—comfort grip I-beam handle he can throw his weight around with; adjustment nut that spins easily in all sizes, 6" to 60"; pipe scale on hookjaw that fits it to pipe without time waste. *For your business*—guarantee against warp or break of housing, no replacement expense and bother, fewer spares needed, *plus* profit from fast, easy work. Follow the lead of enthusiastic users of millions of RIDGID tools—ask your Supply House for these efficient pipe wrenches.

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Richmond, Texas

PAGES 3945 THRU 3964 IN THE COMPOSITE CATALOG

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or even replace the present catalytic refining processes.

"Radio is the obvious form of communication in oil field production operations where no public utility or private wire lines exist. Such operations may be located ten to 50 miles from existing communications facilities where the extension of wire lines is physically impossible or prohibitive in cost. Also, because of the questionable outcome of all wildcat drilling, even though physical extensions of land lines may be possible, often the distances involved indicate that such is not economically sound until production has been found. Thus, use of radio is ideal while new oil or gas fields are being proven, and afterward it serves as an invaluable operating tool for instant contact between field forces and supervisory personnel.

"In isolated locations radio provides a measure of safety for the drilling crews and inhabitants of the immediate vicinity. Aid can be summoned quickly in case of a serious accident, such as a well blowout, explosion, fire or other calamity, perhaps of such magnitude that loss of life and property would be extensive unless adequate help is received without delay. I understand that drilling contractors anticipate the installation of 300 or more transmitters within the next year to take care of their communication problems.

"It is now possible to provide "facsimile transmission" over a radio circuit. Use of this equipment will minimize the shutdown time required to send copies of electrical well logs to the headquarters of the drilling company for examination by geologists and the return of instructions to the drilling crew. Facsimile radio communication may be used also to transmit meter readings, maps and drawings.

"Most pipe line companies, because of facility isolation, were forced to build their own telephone and telegraph wire line systems for their dispatching and operating requirements. Wire lines often fail due to storms and other uncontrollable causes. Radio is ideal to bridge such gaps. With the advent of microwave radio links, which we are told is just around the corner, we can use radio in future pipe line communication systems with all the flexibility now enjoyed with land lines, and enjoy the continuity of service which it affords.

Plane-Station Hookups

"Radio communication between pipe line patrol planes and pump stations along the line of flight is now practicable, and is being considered by some pipe line companies for installation at an early date.

"Radio may be used to activate remote control systems designed to start and stop motors at isolated wells, pipe line gathering systems and tank batteries, and there is no reason why it cannot be used for alarm purposes in pressure systems.

"Tankers at sea and tugs and barges on inland waterways require radio for operating use as well as safety. In addition to use of radio for communications, oil company vessels are now utilizing radar for navigational aid which eliminates the risk of collision in traveling in the dark or through fog.

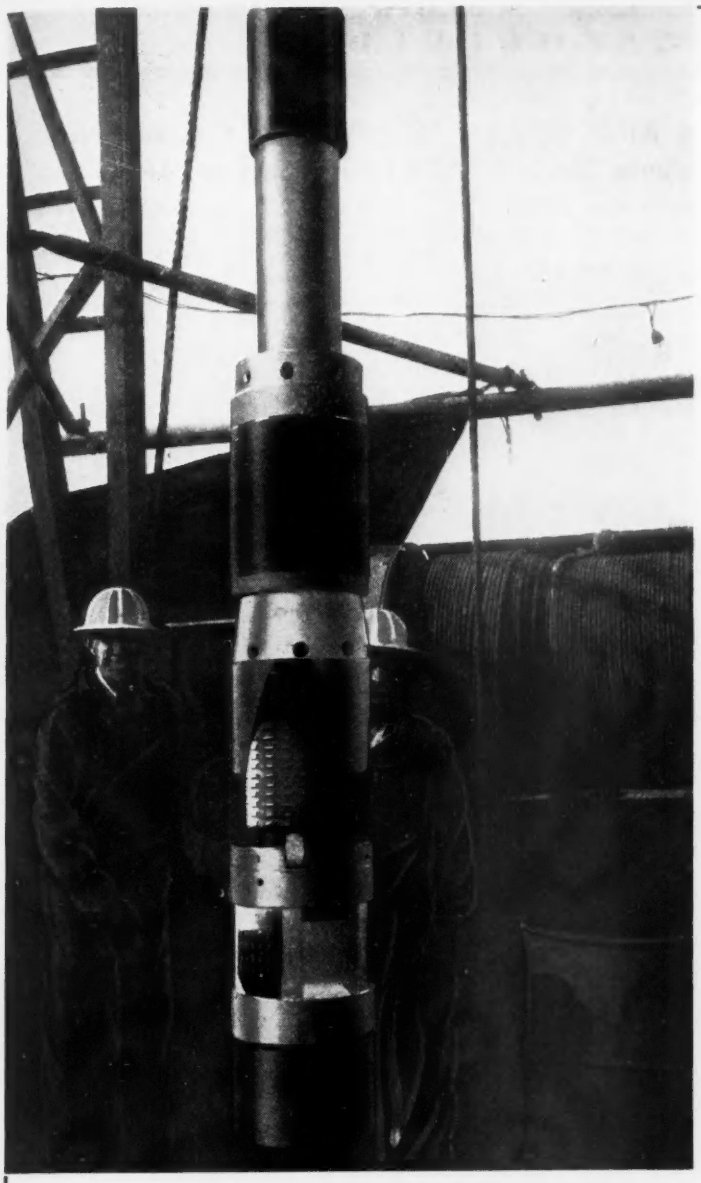
"'Very high frequency' radio waves are used in the laboratories in making experiments dealing with the conversion of oil.

"Distribution of refined products by tank truck can be expedited through dispatching by radio from the bulk depot or other control centers."

THE OIL MAN'S CALENDAR

JAN. 7	Independent Oil Men's Association of New England, Annual Meeting, Boston, Statler Hotel.
14–15	Northwest Petroleum Association, Annual Meeting, St. Paul, Minn., St. Paul Hotel.
14–15	American Association of Petroleum Geologists, Regional Meeting, St. Louis, Jefferson Hotel.
FEB. 15–19	American Institute of Mining and Metallurgical Engineers, Annual Meeting, New York, Pennsylvania Hotel.
16–17	Kansas Oil Men's Association, Annual Meeting, Wichita.
MAR. 9–10	Wisconsin Petroleum Association, Milwaukee, Schroeder Hotel.
12–14	Texas Independent Producers and Royalty Owners' Association, Annual Meeting, Corpus Christi.
24–26	Natural Gasoline Association of America, Annual Meeting, Ft. Worth, Texas Hotel.
24–26	Southern Gas Association, Galveston, Texas.
24–26	American Petroleum Institute, Mid-Continent District, Wichita Kansas, Broadview Hotel.
APRIL 14–16	American Petroleum Institute, Southwestern District Meeting, San Antonio, Plaza Hotel.
21–23	National Petroleum Association, Cleveland, Hotel Cleveland.
25–27	Independent Petroleum Association of America, Mid-Year Meeting, Wichita, Kansas, Broadview Hotel.
26–29	American Association of Petroleum Geologists, Society of Economic Paleontologists & Minerologists, Society of Exploration Geophysicists, Annual Meeting, Denver, Shirley-Savoy Hotel.
28–30	Liquefied Petroleum Gas Association, Annual Convention and Trade Show, Kansas City, Mo.
MAY 4– 5	American Gas Association, Natural Gas Department, Annual Spring Meeting, Houston, Rice Hotel.
6– 7	American Petroleum Institute, Pacific Coast District Meeting, Los Angeles, Biltmore Hotel.
15–22	International Petroleum Exposition, Tulsa.
JUNE 30 July 2	American Petroleum Institute, Eastern District Meeting, White Sulphur Springs, W. Va., Greenbrier Hotel.
JUNE 30 July 3	Canadian Gas Association, Annual Convention, Jasper, Alberta, Jasper Park Lodge.
SEPT. 15–17	National Petroleum Association, Atlantic City, N. J., Hotel Traymore.
OCT. 4– 9	American Gas Association, Atlantic City.
NOV. 8–11	American Petroleum Institute, Annual Meeting, Chicago, Stevens Hotel.

Nomads Chapter monthly meetings: **Los Angeles**, second Wednesday, Jonathan Club, B. M. Landis, Secretary. **Houston**, second Monday, Houston Club, Harry E. Estes, Secretary, Telephone Charter 4-7611. **Dallas**, L. A. Little, Secretary, Telephone Justin 8-1726. **Tulsa**, third Wednesday, Hotel Tulsa, Anthony Gibbon, Secretary, Telephone 3-1844. **New York**, first Monday, Louis Sherry's, Norris Boulden, Secretary, Telephone WIckersham 2-1311, extension 260



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HOOK WALL PACKER

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Yes—the Wilson "Positive Seal" Hook Wall Packer is making friends throughout the Industry—because it gets the job done, even under adverse conditions.

Due to the patented design of the expander cone, this Packer will withstand the extremely high differential pressures usually encountered in Dual Completion Wells.

The non-vulcanizing pack-off element is expanded by conical wedge—and does not depend on excessive tubing weight on Packer to secure pack-off. The split pack-off gives a "lip-seal" which means that the higher the pressure from below—the tighter the seal.

In the Wilson "Positive Seal" Hook Wall Packer, three friction blocks, hard faced with stellite, are used in place of friction wiper springs. These friction blocks are held against the wall of casing by three rugged coil springs—and insure correct setting regardless of depth.

In any specified pipe size one packing element fits all weights of pipe. This feature means small inventories, also, more important, Packer can be set in "mixed" strings of casing.

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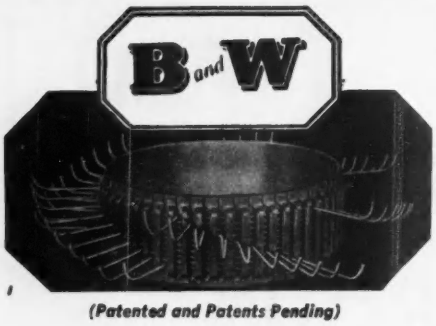

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PAGE 283

ASSOCIATIONS

Wrather Named AIME Head; Two Vice Presidents Chosen

Election of William Embry Wrather of Washington, D. C., as president of the American Institute of Mining and Metallurgical Engineers was announced by the board of directors. Dr. Wrather is director of the U. S. Geological Survey. Two vice presidents elected were C. Harry Benedict, of the Calumet & Hecla Consolidated Copper Company, Lake Linden, Mich.; and Donald H. McLaughlin, president, Homestake Mining Company, San Francisco. Five new directors elected were Newell G. Alford, consulting engineer, Pittsburgh; Richard J. Ennis, general manager, McIntyre-Porcupine Mines, Ltd., Schumacher, Ontario, Canada; J. B. Haffner, general manager, Bunker Hill & Sullivan Mining & Concentrating Company, Kellogg, Idaho; Albert J. Phillips, superintendent, Research Department, American Smelting & Refining Company, Barber, N. J., and Cresap P. Watson, vice president, Seaboard Oil Company, Los Angeles.

W. E. Wrather

Also elected were six new directors ex officiis as chairmen of professional divisions of the Institute. They are A. A. Smith, Jr. (chairman, Institute of Metals Division) American Smelting & Refining Company, Barber, N. J.; Irwin W. Alcorn (chairman, Petroleum Division) The Pure Oil Company, Houston; Gilbert Soler (chairman, Iron and Steel Division) general superintendent, Atlas Steels, Ltd., Welland, Ontario, Canada; Clayton G. Ball (chairman, Coal Division) Paul Weir Associates, Chicago; Curtis L. Wilson (chairman, Mineral Industry Education Division) dean, Missouri School of Mines and Metallurgy, Rolla, Mo.; Richard W. Smith (chairman, Industrial Minerals Division) Natural Resources Department, U. S Chamber of Commerce, Washington, D. C.

Buchanan Chairman of API General Arrangements Group

Al Buchanan of Al Buchanan Drilling Comapny, San Antonio, has been appointed chairman of the general arrangements committee for the spring meeting of the Southwestern District, API Division of Production, April 14-16 at the Plaza Hotel, San Antonio.

Other committee chairmen are as follows: Program, R. E. Bridges, Humble Oil & Refining Company, Houston; registration, R. S. Christie, Amerada Petroleum Corporation, Fort Worth; meeting room arrangements, John B. Stephens, The National Supply Company, San Antonio; publicity, B. D. Stevenson, San Antonio *Express*, San Antonio; entertainment, Frank B. Lefevre, independent producer, San Antonio; advisory, W. V. Vietti, The Texas Company, Houston.

W. P. Winham Elected Head Of Pacific Section, AAPG

William P. Winham, manager of exploration, Standard Oil Company of California's Southern District, was named president at the fall meeting of the Pacific Section, American Association of Petroleum Geologists, at Pasadena.

Harvey Lee, Land Department, Union Oil Company, Los Angeles, was named vice president; and Peter Gardett, geologist, General Petroleum Corporation, Los Angeles, was elected secretary-treasurer.

The Pacific Section, Society of Economic Paleontologists and Mineralogists elected as follows: president, A. Theodore Lee, geologist, Barnsdall Oil Company, Los Angeles; secretary-treasurer, Zilda Cross, assistant to Wilbur Rankin, Los Angeles consultant.

Wyoming Society Elects

Henry C. Rey, consultant, was named president at the annual election of the Wyoming Geological Society. M. P. Tixier, Schlumberger Well Surveying Corporation, was named first vice president; W. S. Knouse, Tide Water Associated Oil Company, second vice president; and H. E. Summerford, Chemical Laboratories, Inc., secretary-treasurer.

50th Anniversary Observed By West Virginia Survey

Fiftieth anniversary of the West Virginia Geological Survey was celebrated last month at a joint meeting with the Appalachian Geological Society of Charleston, W. Va., and the Oil and Gas Section of the Engineers Society of Western Pennsylvania, Pittsburgh.

Activities began with an open house in the Survey offices. Guests viewed various displays and exhibits of the Survey's past progress and its present projects.

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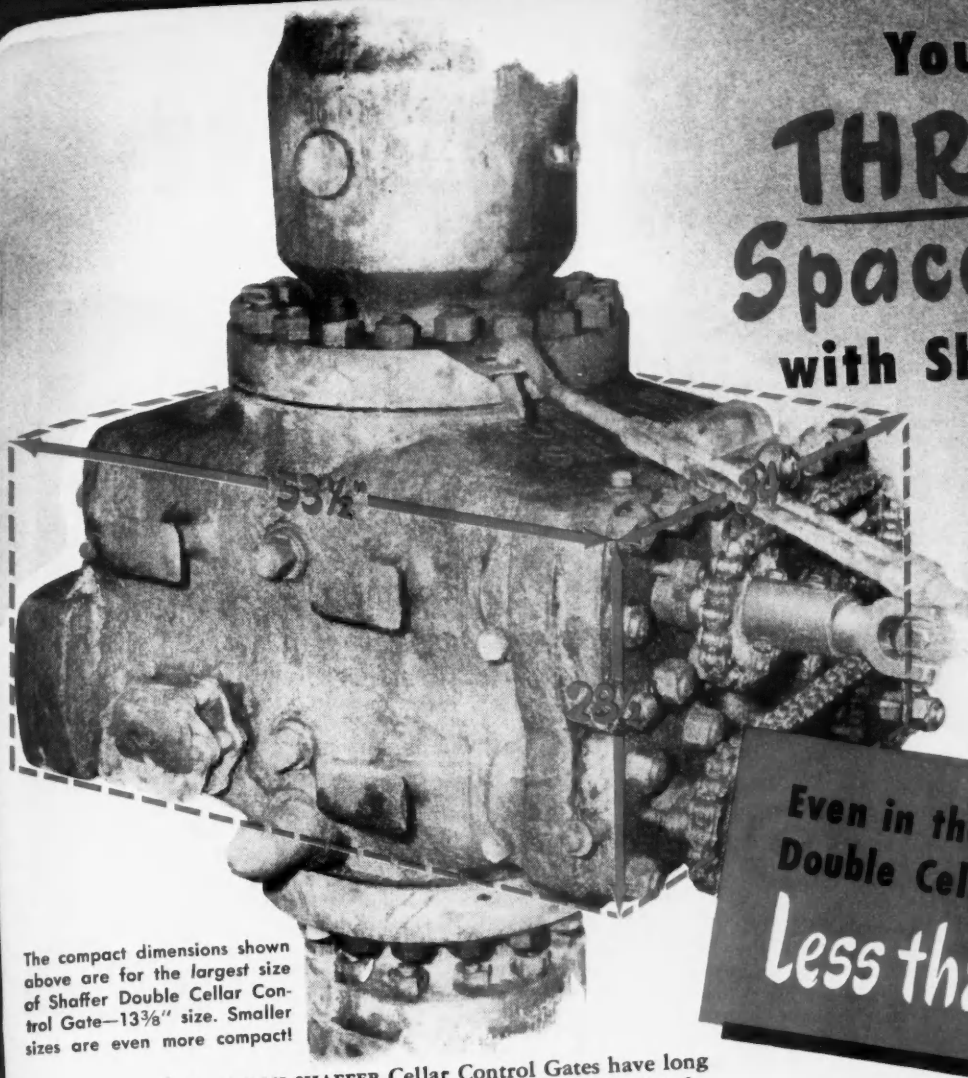

The compact dimensions shown above are for the *largest* size of Shaffer Double Cellar Control Gate—13⅜" size. Smaller sizes are even more compact!

Even in the LARGEST size—a Shaffer Double Cellar Control Gate measures

Less than 29" × 34" × 54"

ALTHOUGH SHAFFER Cellar Control Gates have long been noted for their unusually small overall *height*, also keep in mind that Shaffer Gates are amazingly compact in *length* and *width*, too. This means that Shaffer Gates not only minimize costly cellar depth requirements and permit lower rig floors, but in addition, they assure more *all-around* space in the cellar and make possible a cleaner, more compact rig hook-up.

For example, check the three-way compactness of the 13⅜" Shaffer Double Cellar Control Gate which is the largest size built. Although it combines TWO complete ram compartments in *one* body—with rams in the upper compartment for closing off around pipe and rams in the lower compartment for closing off open hole—this Shaffer Double Cellar Control Gate measures only 28½" high, 34" wide and 53½" long—a cellar-saving compactness unequalled by any other gate of equal bore. *And Shaffer Double Gates of smaller sizes are even more compact!*

IN ADDITION, not only does the Shaffer Double Cellar Control Gate afford maximum overall compactness, but it provides the extra space-saving feature of having an integral mud cross built into the Gate body just below the lower ram compartment. Two 2-inch or 3-inch outlets are provided which can be connected with fill-up lines to serve as a mud cross or for use in relieving well pressure when the Gate rams are closed. No need to waste space with the conventional mud cross.

THERE'S OUTSTANDING SUPERIORITY IN EVERY PHASE OF SHAFFER CELLAR CONTROL GATE OPERATION . . .

Shaffer's three-way space compactness is only one of many points of Shaffer superiority. In fact, on *every* important feature essential to maximum safety and efficiency, Shaffer Cellar Control Gates offer vital advantages that save money, save space and assure maximum safety in cellar control gate protection...

WIDE CHOICE OF POWER DRIVES: Shaffer Gates can be operated with virtually any type of power—air, hydraulic, steam or electric—*plus* the permanent added safety of a manual stand-by. All Shaffer Auxiliary Power Drive units are easy and simple to install without complicated pipe manifolding or cellar clutter—and with *all* drives, control is centralized at the driller's fingertips!

FOOL-PROOF NON-CREEPING RAMS: Positive mechanical screw feed not only assures quick foolproof ram operation at all times, but also firmly holds Shaffer rams in whatever position they are set without need for auxiliary locking devices or extra operations. Simply close the Shaffer Gate and it *stays* closed until the operator wishes to open it!

EASY RAM CHANGEOVERS: From the very first gate built, Shaffer has always featured maximum speed and simplicity in changing rams. Just remove one end cover and the *complete* ram assembly is accessible for changing the rams. Replace the end cover and the job's done. It's as simple and fast as that, reducing labor costs and saving valuable time when changing from one pipe size to another!

SEND FOR COMPLETE INFORMATION on the many other ways in which Shaffer Cellar Control Gate advantages assure greater safety, higher operating efficiency, simpler and more compact installations.

See pages 3454 to 3506 of your 1947 Composite Catalog for additional information on Shaffer products!

Send for your free copy of the new Shaffer Catalog!

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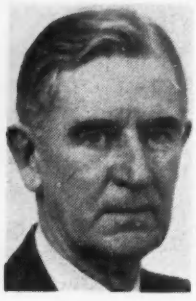
Men in the Industry NEWS



Ray C. Johnson

F. V. Wallace

Ray C. Johnson was elected vice president and general counsel of the Shamrock Oil and Gas Corporation and **F. V. Wallace** and **B. E. Tyler, Jr.**, were chosen secretary and treasurer, respectively. Johnson, who will continue to serve as a director of the corporation, has been with the company since its organization as an attorney and in more recent years as secretary-treasurer and a member of the board of directors. Wallace joined Shamrock in 1934 as clerk at the Mel Davis Refinery near LeFors, Texas. In 1935 he became chief clerk at the McKee Plant near Dumas, Texas, and in 1945 he was transferred to Amarillo as personnel manager, later becoming office assistant to the president. Tyler joined Shamrock in 1937 as office manager. He was elected assistant secretary and assistant treasurer in 1941.

B. E. Tyler, Jr.

»

A. E. Bradshaw, president of the National Bank of Tulsa, was reelected chairman of the board of directors of the Oklahoma Natural Gas Company. Also reelected as board members were **Joseph Bowers,** company president; **Dudley L. Morgan, Clyde H. Pate, Fred W. Peters, L. C. Ritts** and **W. G. Skelly,** all of Tulsa; **R. C. Allen,** Wilmington, Del.; **J. F. Darby,** Muskogee, Okla.; **George Frederickson,** Oklahoma City, and **John Mitchell,** Jeanerette, La.

»

George W. Robey, former sheriff of Coleman County, Texas, has been added to the staff of the Texas Mid-Continent Oil & Gas Association. Robey joins **John W. Kelley,** veteran special investigator and former Breckenridge chief of police, in the Association's theft prevention campaign against thieves who menace oil company supplies and equipment.

»

C. F. Hancock Jr., has resigned as geologist-engineer for Tex Harvey Oil Company of Dallas and has joined the **George S. Engle** organization at Henderson, Ky.

John Bukvic has joined the staff of the Montana School of Mines as assistant professor in the new petroleum engineering department. A native of Butte, he received his B.Sc. degree in mining engineering from the School of Mines in 1939, following this up with a master's degree in 1940. After working as sampler and shift boss he was appointed instructor in mathematics at the Montana School of Mines, leaving there to become a petroleum engineer for The Texas Company.

»

K. G. Shepard has been named district superintendent of the Mabee Petroleum Company at Grayville, Ill. The company recently opened the office there after acquiring the properties of the Mabee Oil and Gas Company.

»

George H. Pappas and **W. E. Brubeck** have established a geological consulting firm at Mt. Carmel, Ill.

»

Howard C. Pyle has resigned as vice president of the Bank of America in charge of oil loans to become president of Continental Corporation, Continental Development Corporation, and Continental Northern and Southern Corporations, succeeding **Robert V. New,** whose interests and those of **R. F. Ingold** and The Harwood Foundation have been acquired by Continental Consolidated Corporation, all of the stock of which is owned by **E. C. Simmons,** who will serve as chairman of the board of directors of the companies. The Continental companies own 63 producing oil wells in an extension of the Wilmington pool, with about 125 wells in addition yet to be drilled to the Ranger zone.

»

Robert W. Miller, California industrialist, was elected to the board of directors of Standard Oil Company of California. Miller is president of Pacific Lighting Corporation, director of the American Trust Company, The Paraffine Companies, Inc., Tucker Investment Company and Pacific Public Service. He has been an officer of Pacific Lighting since 1924 and was elected executive vice president of that company in 1929 and president in 1940.

»

William A. Underwood, assistant to the comptroller of Standard Oil Company (Indiana), and **Yates S. Williams,** assistant controller of the Reynolds Metals Company, have been elected assistant comptrollers of Standard Oil Company (Indiana).

»

Dr. Arthur B. Hersberger was named manager of the new Chemical Product Division of The Atlantic Refining Company. Dr. Hersberger has served with Atlantic's Research and Development Department since 1936.

A. J. Galloway

H. Bloemgarten

H. Bloemgarten, vice president of exploration and production for Shell Oil Company, Inc., has been appointed managing director in charge of technical operations of the Royal Dutch Shell companies. **A. J. Galloway,** regional vice president for Shell in Houston, succeeds Bloemgarten. **E. D. Cumming,** manager of Shell's American department in London, succeeds Galloway. Bloemgarten has been with Shell more than 25 years. In 1935 he was named vice president in charge of production at St. Louis, and since 1942 he has made his headquarters at New York. His new headquarters will be at The Hague. Galloway joined Shell in 1926, and in 1934 was made vice president of Shell Petroleum Corporation at St. Louis. He remained in this position through 1939, when Shell Petroleum was consolidated with Shell Oil Company, Inc. He moved to Houston in 1940 as regional vice president of the Texas-Gulf and Mid-Continent areas. Cumming spent the early part of his career with Shell in technical positions on the Pacific Coast. In 1938 he became manager of the Wood River, Illinois, refinery, and in 1939 vice president in charge of manufacturing. He was made vice president in charge of exploration and production on the Pacific Coast in 1944.

E. D. Cumming

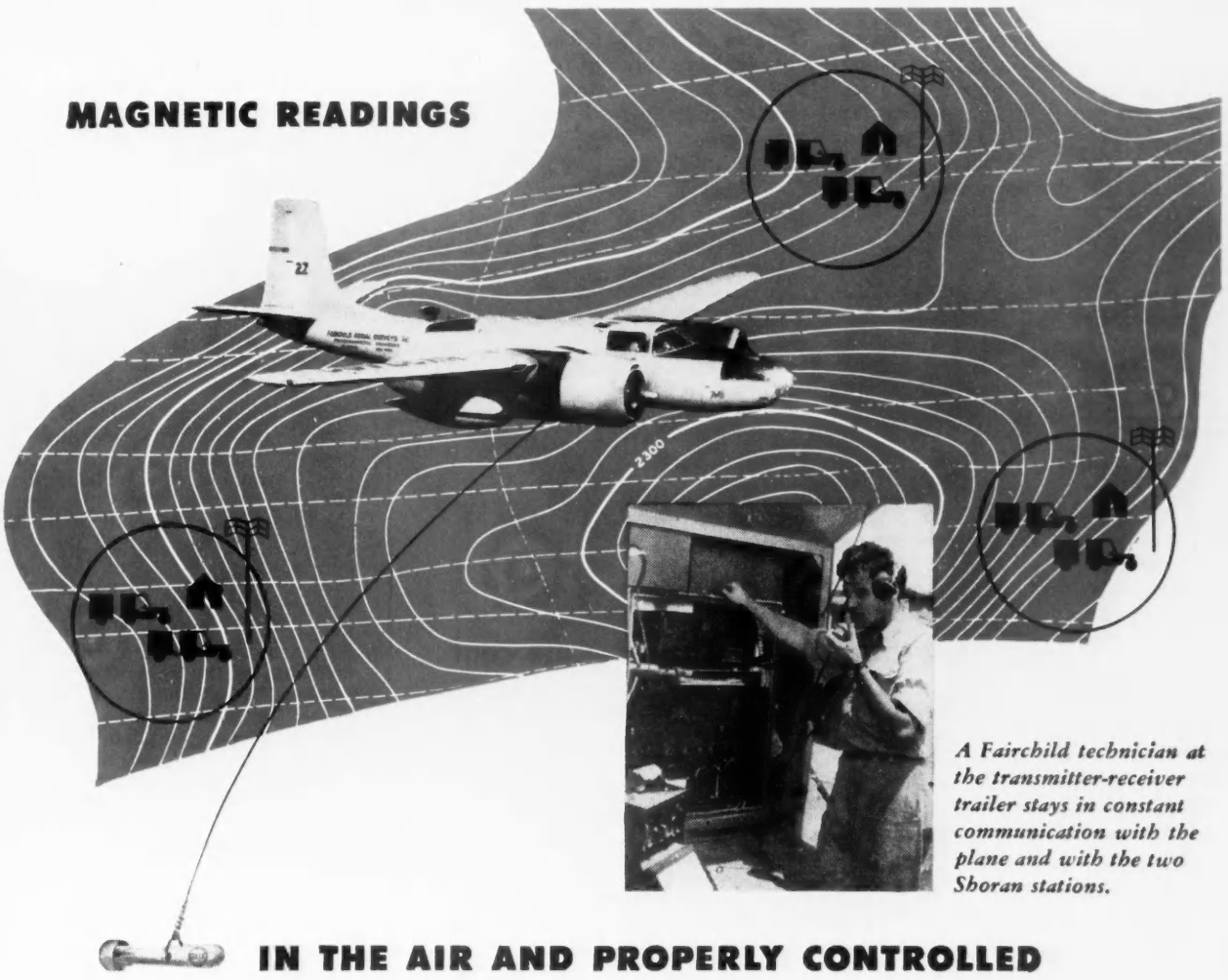
»

Dr. Frank J. Soday has been named director of research for Lion Oil Company. Dr. Soday formerly was technical director for Copolymer Corporation of Baton Rouge, La., and more recently was director of research for Devoe and Raynolds Company, Louisville.

»

Alec Crowell has opened offices in the Commercial National Bank Building and will represent several producers of natural gas, and act as broker for two natural gas pipe line companies in the purchase of gas in the Arkansas-Louisiana-Texas area.

MAGNETIC READINGS



A Fairchild technician at the transmitter-receiver trailer stays in constant communication with the plane and with the two Shoran stations.

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Magnetometer surveys once handicapped by local ground effects are freed by the airborne-type magnetic survey developed by Fairchild and utilizing Gulf Oil Company instruments. These airborne instruments provide a new horizon in magnetic mapping . . . eliminating the inaccuracies inherent to ground magnetic mapping methods.

Fairchild has developed flight patterns and control methods that permit checks and double-checks at navigational points in the survey area. Thus, engineers may adjust, correct and balance the readings obtained with the airborne instruments. These data supplied by the expeditionary force provide the precise information needed to produce the finished magnetic maps.

When planning a survey, call in Fairchild engineers for your early conferences . . . their help is available to you at no obligation for your preliminary survey studies.

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Robert E. Pinkston, with the Railroad Commission in Austin for approximately five years as proration engineer and for the past two years with Snowden Oil and Gas Company, Ltd., Dallas, as assistant general superintendent, has returned to Austin and opened an oil and gas operators' service office at 913½ Colorado.

»

J. C. Vaughn of Carey, Ohio, was awarded the Shell Fellowship in Petroleum Production Engineering at The Ohio State University.

Douglas Orme has been named vice president in charge of traffic for Cosden Petroleum Corporation. Orme joined Cosden in 1929 and has served continuously in the Traffic Department. He became traffic manager in 1935.

»

E. A. Berthoud has relinquished his appointment as Undersecretary to the Ministry of Fuel and Power in England as a result of his transfer to the Foreign Office. **Victor Butler** is now responsible for the Petroleum Division.

Eldon Young

Archie D. Gray

Eldon Young and **Archie D. Gray** were named general attorney and associate general attorney, respectively, for Gulf Oil Corporation with headquarters in Houston. Young, under the direction of the general counsel, will be in charge of the legal problems of all the Gulf companies, except litigation, throughout the area in which the companies' operations are supervised from offices in Texas, mainly, Texas, Louisiana, Mississippi, Arkansas and Mexico. Gray, under the direction of the general counsel, will be in charge of all the litigation of the Gulf companies in the same area and the litigation of major importance elsewhere in the U. S. Both have been in the Law Department of the Gulf companies for many years. Young was for several years in charge of the Law Department office in New York. Gray was an Assistant Attorney General of Texas prior to his employment by Gulf.

»

Garrett L. Bolyard, formerly of Tulsa, has joined the geological staff of Barnsdall Oil Company at Oklahoma City.

»

Hugh Gaitskell has succeded **Emmanuel Shinwell** as British Minister of Fuel and Power under the recent government changes. The Minister of Fuel no longer has a seat in the cabinet as a result of the overall supervision to be exercised by the Minister of Economic Affairs, **Sir Stafford Cripps.** The new Minister of Fuel is 41, and has been Shinwell's right-hand man since May of last year.

»

Joseph L. Hargrove, senior petroleum engineering student at The University of Texas, won the student contest on technical papers at the recent joint meeting of all Texas Sections of AIME. A cash prize was awarded by the Gulf Coast Section. Title of his paper was, "Interpretations, Uses, and Applications of Radioactivity Logging." Hargrove is 21 years old and a native of Shreveport. He is a member of the Kappa Alpha social fraternity and of Sigma Gamma Epsilon, honorary earth sciences fraternity.

Joseph L. Hargrove

What is YOUR "Bit Cost Per Foot Drilled?"

Hawthorne Bits Average One cent per foot Less than Conventional Bits

ACCORDING to records kept by the party chief and drillers of a major oil company, one cent per foot drilled was the average bit savings made by Hawthorne Replaceable Blade Bits, running in the same area, on alternating holes, against conventional fishtail bits. In addition, Hawthorne Bits cut many hard formations that had to be drilled with roller bits in competing holes . . . these savings are *not* reflected in the records.

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MEN IN THE INDUSTRY NEWS

Transfers:

Kenneth Brill, landman for Continental Oil Company, has been transferred from Ponca City, Okla., to Denver to handle the Rocky Mountain area land office.

⌄⌄

J. J. Statler of Shreveport, La., to Fort Worth, Texas, to open a district land office for British-American Oil Producing Company, covering North Texas and the Permian Basin. He has been succeeded by **W. F. Mugler.**

⌄⌄

The following transfers and promotions have been announced by Cities Service Oil Company: **Oscar Bowen** from superintendent of the Warrensburg district to superintendent at the Drumright station, replacing **Harvey German,** resigned; **Frank Harriger** from foreman at Wewoka to superintendent at Warrensburg; **Frederick Crossman** from engineer at the Petrolia station to engineer at Depew station; **Lee Davis** from timekeeper at the Welda station to timekeeper for Tallant pipe line district; **H. L. Julien** from oiler at Caney station to engineer at the Hutchinson station.

⌄⌄

R. Eugene Zimmerman transferred from Houston to Shreveport as district land man for Houston Oil Company of Texas, replacing **John R. Murphrey,** resigned, to become an independent operator.

⌄⌄

P. T. Amstuts, Jr., engineer with Sohio Petroleum Company, from Oklahoma City to Wichita, Kansas. **Charles R. Boyd,** foreman for Phillips Petroleum Company from Guymon to Edmond, Okla. **C. M. Ross,** geologist with Amerada Petroleum Corporation, from Aztec, N. M., to Ardmore, Okla.

⌄⌄

The following changes in the scouting department of Stanolind Oil & Gas Company, Tulsa, have been announced: **H. A. Weatherby,** manager of scouting; **J. T. Perkins,** chief scout; **J. C. Mytinger, Jr.,** and **H. H. Kaurez,** assistant chief scouts; **J. W. Shoemaker,** scout at Tyler, Texas.

⌄⌄

R. W. Hamlet is retiring as an assistant treasurer of Socony-Vacuum Oil Company, Inc., after more than 37 years of service. **George F. Molter,** who has been with the company since 1934, has been elected an assistant treasurer.

⌄⌄

W. M. Hall was named a director of Creole Petroleum Corporation to succeed **L. F. McCollum,** resigned. Hall has ben associated with Standard Oil Company (N.J.) and its affiliated interests since 1921, when he joined the company as a rig builder. After serving in foreign assignments for more than 22 years, he went to New York to join the Foreign Producing Department of Standard Oil Company (N.J.). In 1946, he joined Creole Petroleum Corporation in Venezuela as assistant general manager and a member of the management committee.

⌄⌄

V. H. Miller, formerly an independent operator at Oklahoma City, is now operating out of Carmi, Ill.

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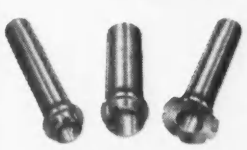
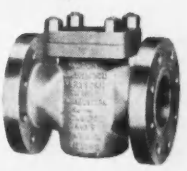
FALCON Liners are available for every principal make and model of Slush Pump. Send for illustrated bulletin and price list.

OTHER FALCON PRODUCTS



Swivel Wash Pipes

Piston Rods



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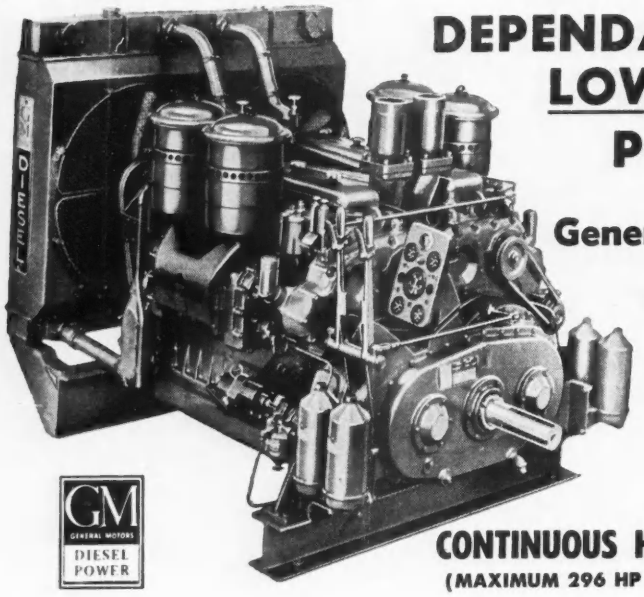
Export Representative: Guy E. Daniels, 30 Rockefeller Plaza, New York 20, N. Y.

Theodore C. Bodley has resigned as supervisor of crude oil supply for Mid-Continent Pipe Line Corporation to join Sunray Oil Corporation as manager of crude oil purchases and sales. Bodley majored in petroleum refining engineering at Tulsa University and in 1938 joined Mid-Continent Pipe Line Corporation as a laborer on the connection gang. He was promoted to stock gauger, engineer-gauger, district clerk, oil dispatcher and civil engineer and for the past three years has been supervisor under **President J. M. Linehan.**

Dr. William H. Twenhofel, geologist and an authority on sedimentation, will join the Tulsa University Geology faculty next semester. Dr. Twenhofel holds the position of professor emeritus at Wisconsin University and is currently lecturing at Yale University.

»

Sigfrid E. Floren, Jr., has resigned as clerk to **Bower Broaddus,** federal judge at Oklahoma City, to join Phillips Petroleum Company's legal staff in the Oklahoma City office.



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There is a GM Diesel for your every need . . . ranging in size from 30 to 700 Horsepower. Most models in stock in our New Orleans plant. Write for brochure.

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Manager

J. Frank Wilson has been elected a vice president of The Standard Oil Company (Ohio) in charge of crude oil purchasing. A native of Lexington, Ky., and vice president of Sohio Petroleum Company since January, 1944, Wilson joined Sohio in 1935 after more than 15 years in crude oil procurement activities. He is president of the Ohio River Pipeline Company, vice president of Owensboro-Ashland Company, vice president of Columbia Pipeline Company, vice president of Sohio Pipeline Company, and a director of Atlas Oil and Refining Company. He will continue to maintain headquarters at St. Louis.

J. Frank Wilson

»

Herbert F. Miller, vice president, director and head of the crude oil purchasing department of The Carter Oil Company, on December 1 completed 45 years of continuous service with Standard Oil Company (N. J.) and affiliates. He started with the Jersey company in New York in 1902 as an office boy at the age of 16. For more than ten years he was administrative secretary to **Walter C. Teagle,** then president of Standard Oil Company (N. J.). Miller went to Tulsa in 1921, with The Carter Oil Company, was made a director of the company in 1933, and elected vice president in August, 1947.

»

Ed N. Foster was named Houston Division purchasing agent for the Gulf companies, succeeding the late **L. S. Cooper.** Foster joined Gulf 29 years ago and went to Houston in 1946 as first assistant to the purchasing agent. **Kenneth R. Woodham** has become first assistant division purchasing agent, succeeding Foster. **J. R. Berwick** was named assistant purchasing agent.

»

Robert B. Campbell, consulting geologist of Gulf Hammock, Fla., presented a paper on "The Changing Picture in the World Petroleum Industry" before the Florida Academy of Sciences at Tallahassee.

»

Dr. W. H. Stueve, director of industrial development, Oklahoma Gas & Electric Company, Oklahoma City, has been elected a Fellow of the American Society of Mechanical Engineers.

»

M. L. McGee, in charge of Vickers Petroleum Corporation operations in Oklahoma, has opened a division office at Midland, Texas, and will have charge of operations in West Texas and New Mexico. He has been succeeded by **A. S. Bunte.**

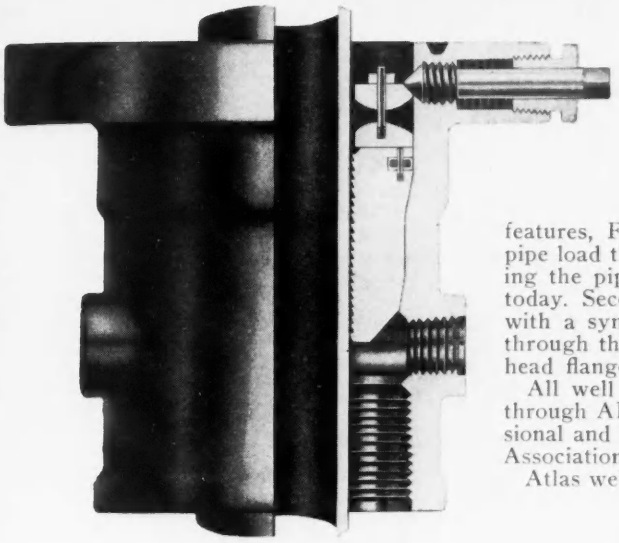
»

Robert F. White, Sohio Petroleum Company, has moved from St. Louis to Wichita, Kansas, where he will head a new crude oil purchasing department.

SSD

STANDS FOR ATLAS BASIC PRINCIPLES

Safety · Simplicity · Durability



ATLAS TYPE H.S.W. WELL HEAD

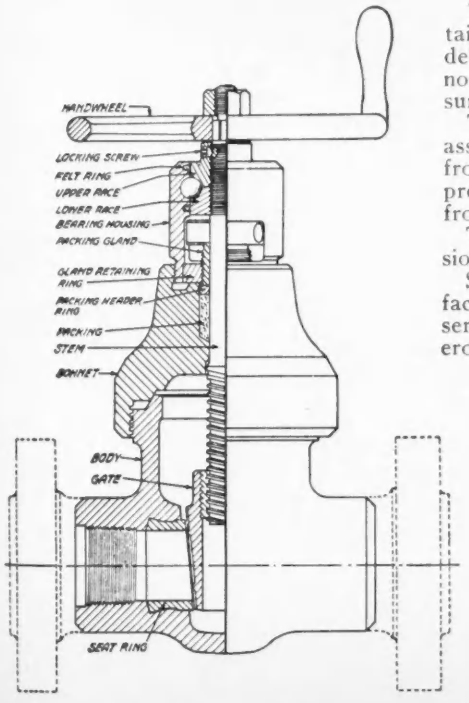
The Atlas Engineering Works in keeping with the continuous improvements in oil field equipment announces that their entire line of equipment has always had three basic principles in design, viz.: Safety, Simplicity and Durability. Every piece of equipment has been given thorough engineering study so that the ultimate in performance has been achieved.

The Atlas type H.S.W. casing head embodies two important features, First, the double tapered slips which insures perfect alignment of pipe load the entire length of slip surface. This eliminates the hazard of crushing the pipe on the long heavy strings now being used in the deep wells of today. Secondly, the sealing member composed of two steel back up plates with a synthetic sealing rubber between, is easily placed in the casing head through the blow-out preventers and locked in place by lock screws in casing head flange.

All well heads are full casing opening allowing the setting of all hangers through API flanged blow-out preventers. All flanges are made to both dimensional and material specifications of the American Petroleum Institute and the Association of Well Head Equipment Manufacturers.

Atlas well head equipment is available in all types, sizes and pressure ranges.

ATLAS-HUGHES BALL THRUST VALVES



The same care as always exercised in producing high quality valves will be maintained by Atlas Engineering Works and stocks will be available for immediate delivery. These valves are made from carefully selected alloy steel; they are of the non-rising stem, solid wedge type, with ball-bearing stem thrust, hard-faced seating surfaces with either flanged or screwed ends.

THE STEM THRUST is rugged, heavy duty, steel ball-bearing, grease-packed to assure ease of operation. The external location of the ball thrust bearing protects it from possible injury by corrosive well fluids. The Valve is readily repacked under pressure, and if necessary the ball race can be replaced without removing the Valve from service.

THE STEM is made of heat-treated stainless steel to reduce the danger of corrosion, while the special "Acme" thread insures ease of operation and resists wear.

SEATING SURFACES on both Gates and Seats are faced with hard, stainless, non-galling alloy which field service has proven highly resistant to both corrosion and erosion. The hard-faced seat rings are expanded into the body recesses by hydraulic pressure. Laboratory tests have proven this construction rugged and leak-proof at pressures far in excess of the rated test.

THE PACKING GLAND is enclosed. Adjustment of the improved packing is seldom necessary, but is readily made by inserting a round bar through the slotted ball race housing into holes of ample size provided in the packing gland.

THE BONNET is a one-piece forging with ground joint connection to the body. It is given a special chemical treatment which resists corrosion and prevents galling or scoring of the sealing surface.

THE HAND WHEEL is provided with a handle for convenience and easy operation.

Complete ATLAS Catalog data available on request.

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DEATHS

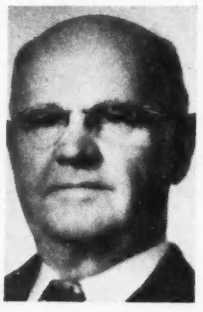
Buell F. Jones, 54, vice president and general counsel of Standard Oil Company (Indiana), died November 17 at Chicago following an extended illness. A native of Spain, S.D., Jones entered law practice at Britton, S.D., in 1914. With entry of the U. S. into World War I he interrupted his practice to raise a troop of cavalry. Shortly after World War I, Jones served as prosecuting attorney of his home county and was appointed a member of the state bonus board. In 1922 he was elected attorney general of South Dakota, in which position he served three terms. He joined Standard of Indiana in 1930, was made general counsel in 1940, was elected to the board of directors in 1942, and made a vice president in 1945.

Horace G. Wilcox, 71, Colorado Springs, Colo., died November 22 of a heart attack. He was an oil operator in Oklahoma and Kansas.

»

Gus Blanton, 47, native of Hewitt, Texas, and employe of Humble Oil & Refining Company for 15 years, was found dead November 26.

Rogers E. Lacy, 63, East Texas oil man whose 26-acre Gregg County sweet potato patch started him to a $45 million fortune, died December 9 at Longview. He had been ill since September 29, when he suffered a heart attack. Born at Longview on August 18, 1884, Lacy turned first to railroading, then to farming and mercantile ventures. In 1930 he owned 26 acres of sweet potato land which he tried without success to sell for $300. Oil development in 1931 proved his land to be in the heart of the mammoth East Texas field. In addition to his East Texas holdings, Lacy was an important factor in the development of oil in southern Mississippi, where in 1946 he built the state's second refinery. A year ago he took over 10,000 acres in the Rio Grande Valley and established one of Texas' largest citrus orchards. The land also yielded several oil and gas producers. He owned a block in the heart of Dallas' business district, where he had planned a $10 million, 47-story hotel. This project was dropped when he became ill.



Rogers E. Lacy

»

Adrian V. Seay, 61, Houston, oil official and accounting executive, died November 26 of a cerebral hemmorhage suffered while he was testifying in a civil court suit.

»

Max A. Berns, publicity manager of Universal Atlas Cement Company since 1920, died November 19 at New York. He joined the firm's publicity department in 1913, leaving for two years during World War I, when he was a captain with the Corps of Engineers.

»

Verne Monroe, president and founder of The Cameron Tool & Supply Company, Cameron, W. Va., died November 27.

»

Joseph T. Miller, 62, Tulsa, claims agent and right-of-way buyer for the Gulf Pipe Line Company, died November 12, of injuries received in the collision of his automobile with a train near Indianapolis. He had been a Tulsa resident for 28 years and before joining Gulf had worked for various pipe line companies.

»

Thomas Edison Patrick, 37, manager of Kuwait Oil Company, died November 24 at Baltimore. Patrick, a native of Sour Lake, Texas, joined Gulf Oil Corporation as a production engineer in 1932 and in 1937 was transferred to the Kuwait company as a drilling superintendent. When the war suspended his work, he became field foreman at Grand Bay, La., for Gulf Refining Company and later became a district superintendent. When work was resumed at Kuwait in 1944, he returned as drilling superintendent and subsequently was made manager of the company.

»

W. H. Keffer, 63, vice president in charge of production and pipe lines for Ashland Oil and Refining Company, and a company director, died November 17, at Ashland, Ky., after a brief illness.

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Roller Bearings

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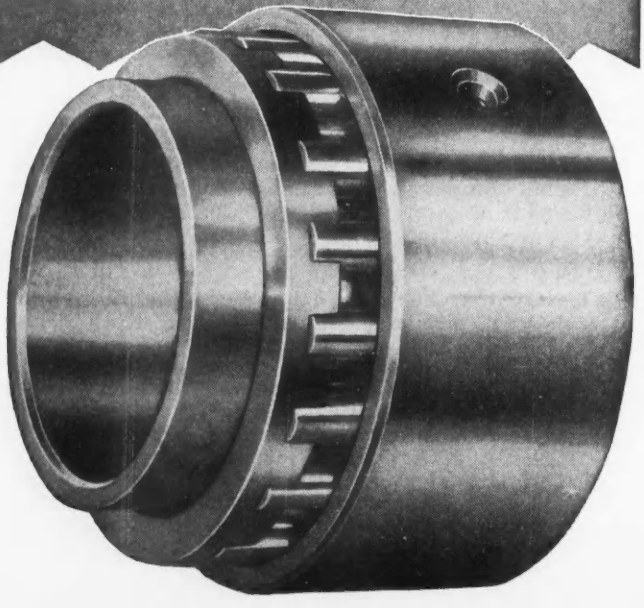

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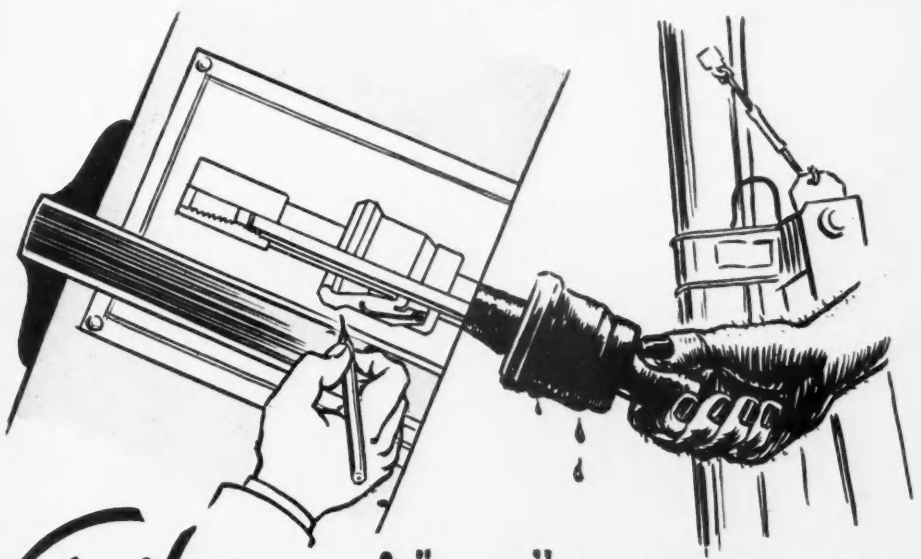

Guiberson's "GW" PACKER CUP

The Guiberson "GW" Packer Cup provides a universal packing element which is adaptable to a multitude of oil field tools and uses such as:

- WELL TESTING TOOLS
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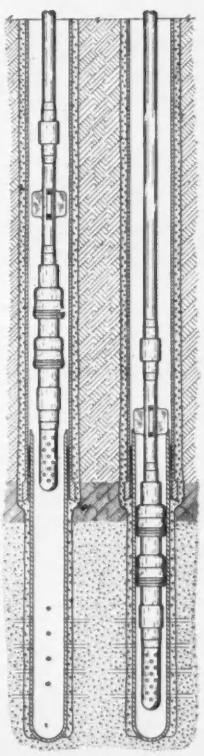
- ACIDIZING TOOLS
- PERFORATED AND SLOTTED PIPE WASHERS
- PRODUCTION PACKERS
- LINER PACKERS
- SPECIAL AND HEAVY-DUTY SWABS
- SAND PUMP PISTONS

Built on the tested and proved basket-type principle, the "GW" Packer Cup is molded of special oil-resistant compound and reinforced with a cage of "hairpin" wires interlocked to a metal bushing. The cups are run in the well oversize and maintain a tight fit with casing wall. The wire cage and metal bushing provide the strength necessary to seal and hold high pressures. The greater the differential pressure across the cup, the tighter the seal.



A B

Many uses for these cups will suggest themselves to the field man. Where a cup-type packer assembly is desired, the Guiberson 2-cup "GW" Packer provides a simplified, dependable tool. Equipped with a mandrel of seamless tubing, it has no locking device to be fouled by mud, shale or sand, and does not require tubing weight to set. It packs off equally well at 100 feet or 10,000 feet.

In the sketch *A*, a packer using two "GW" cups is being run-in. Note the fluid passage around the packer before it enters the liner. *B* shows the packer sealing in top of the liner with the tubing supported by a wing coupling.

Guiberson "GW" Packer Cups are available with or without thimbles for tubing and casing from 2" to 10¾".

GUIBERSON
2-cup "GW" Packer

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MANUFACTURERS' AND SUPPLIERS' NOTES

First 25-Year Pins Awarded by Baker

Twenty-five-year service pins were awarded to (top, left to right): George M. Anderson, California sales manager; T. Sutter, executive vice president and general manager; and A. Pazdernik, maintenance machinist. In the lower group are recipients of 20-year service pins. Left to right: Ralph G. Garretson; T. A. Davenport; C. E. Whitney, vice president and manager of the Central Division at Houston; and W. A. Heinzman.

At the annual service pin banquet of the Pacific Division of Baker Oil Tools, Inc., held in Los Angeles, the theme was historical, tracing the growth of the company since its founding in 1913 by R. C. Baker, Sr., still its president. The main office and plant were moved to Los Angeles in 1922, with a total of 12 persons on the payroll. Today there are more than 500 employes, with an additional plant at Houston established in 1936.

The address of Don E. Gilman, chairman of District 5, Public Relations Committee of the oil industry, on "The Layman's Stake in Public Relations" won the approval of the gathering of 255 Baker men and women.

The banquet was notable for the award of more service pins than ever before, and was highlighted by the first presentation of pins for a quarter century of service.

Kansas Sales Representative Named by Cardwell Company

Charles Spitzfaden, Jr., was appointed Kansas sales representative for Cardwell Manufacturing Company, Wichita, Kansas.

Spitzfaden joined Continental Supply Company in 1937. He served with the Navy in the civil engineering corps from 1942 until 1946.

Following release from active duty he rejoined Continental and last April was appointed assistant district manager for Kansas with offices in Wichita.

HOMCO Adds Sales Office for Fort Worth-Dallas Area

The Houston Oil Field Material Company has opened an additional sales office in the Fort Worth-Dallas area. W. B. Will, formerly with HOMCO before World War II, and most recently with HOMCO's Dallas subsidiary, the Briggs-Weaver Machinery Corporation, has been assigned to assist C. L. (Hal) Roach, who is district sales representative in Fort Worth. Will's office will be in the Construction Building, Dallas.

National Supply Firm Transfers Specialist In Diesel Engines

The National Supply Company has transferred Lloyd A. Harris, diesel engine specialist, from the company's Superior Engine Division, Springfield, Ohio, to the Plant Products Division.

Lloyd A. Harris

Harris will represent National Supply in the sales and service of Superior Engines in all branches of the oil industry. His headquarters are at Houston.

Harris was associated with Waukesha Motor Company, Tulsa, prior to joining the Superior Engine Division in 1942. For the past two years he has represented the company in both oil field and municipal sales in Houston, New Orleans and Fort Worth.

Oil Base Moves Head Offices To Plant at Compton, Calif.

Oil Base, Inc., has moved its head offices from Los Angeles to the new plant in Compton, Calif., where all facilities have been combined on a 4½-acre site for the manufacture, packaging, mixing and shipping of Black Magic oil base drilling fluid.

The plant is comprised of an office building, production and storage plant, a sacking plant (under construction) and a premix plant.

The 15-room office building is one story, 2800 square feet, containing seven executive offices, a large reception room, two secretarial offices, a mailing room and modern research and control laboratories.

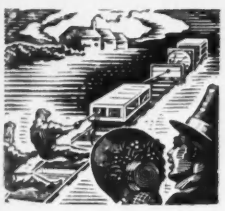
The main plant is housed in a 12,000 square feet steel building. New grinding and mixing equipment has been installed as well as conveyors and handling equipment for storing the sacked materials. A quick-loading ramp for trucks and trailers expedites loadings.

Under construction is a sacking plant for dry mix where machinery for weighing and filling sacks will be housed. At the south end are nine tanks for premixing Black Magic with a total capacity of 3000 barrels per day. Adjacent to the plant building is a two-acre paved lot where a trucking depot, complete with garage for servicing trucks hauling Oil Base products, will be established.

Joins Thornhill-Craver

Jack Skeehan, formerly with Spang-Chalfant Company, Houston and Los Angeles, has joined Thornhill-Craver Company. Skeehan is the Unibolt field representative in the Pacific Coast area with headquarters in Los Angeles.

CONFIDENCE . . . how much is it worth?



IN 1841, two years before the first telegraph line was installed in this country, and when there were but 27 states in the Union, John August Roebling was inspired with the idea of making a new kind of rope of unheard of strength and flexibility. His confidence in his idea caused him to risk everything he had on the development of his new rope.

How much is his confidence worth to Industry today, which couldn't turn a wheel without the modern wire rope?

Today, the John A. Roebling's Sons Company invests much time, effort and money in the development of improved products to keep alive the confidence of its many customers.

Roebling values this confidence as its greatest asset. That's why it offers you the greatest value for every dollar you invest . . . in *any* Roebling product.

HOW TO SAVE WIRE ROPE DOLLARS

Wire rope is a machine of many parts and, like any machine, even the finest of wire ropes can be destroyed quickly through faulty installation or improper maintenance. To insure against this possibility, Roebling established its Field Engineering Service.

Every Roebling Field Engineer has a thorough knowledge of wire rope . . . its types, its uses, its features and limitations. This knowledge plus the experience he gains in his daily contacts can be a great asset to you . . . helping you to solve those tough wire rope problems . . . giving you more service for each wire rope dollar.

Get to know your Roebling Field Engineer. Call him at your nearby Roebling Branch Office.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

FOR EXAMPLE—"BLUE CENTER" STEEL WIRE ROPE

Roebling entrusts your confidence in Roebling and Roebling products to the performance of its "Blue Center" Steel Wire Rope. It is the best rope Roebling knows how to make. It is available as preformed or non-preformed, in a complete range of sizes and constructions to meet a great variety of operating conditions. Its uses are almost unlimited and its performance is consistently economical.

e Rope Distributed by: **THE NATIONAL SUPPLY COMPANY • REPUBLIC SUPPLY COMPANY**

Manufacturers of Wire Rope and Strand • Fittings • Slings • Screen, Hardware and Industrial Wire Cloth • Aerial Wire Rope Systems • Hard, Annealed or Tempered High and Low Carbon Fine and Specialty Wire, Flat Wire, Cold Rolled Strip and Cold Rolled Spring Steel • Ski Lifts • Electrical Wire and Cable • Suspension Bridges and Cables • Aircord, Aircord Terminals and Air Controls • Lawn Mowers

ROEBLING

A CENTURY OF CONFIDENCE

JAR ROEBLING

Thermoid Company Announces Changes in Sales Personnel

Thermoid Company, Trenton, N. J., has announced the following personnel changes:

Jack Brand, formerly assistant sales manager for Thermoid's Automotive Replacement Division at Trenton, will handle industrial sales for Colorado, with headquarters at Denver.

J. J. Chamberlain, formerly associated with Pioneer Rubber Mills of California and the Rubber Division of Paramount Manufacturing Company, will handle industrial sales in Washington and the northern half of Oregon, with headquarters in Seattle.

E. J. Dunlap has been transferred from Trenton, N. J., where he headed industrial sales promotion, to San Francisco, where he will have charge of industrial sales for the northern half of California and southern Oregon.

A. Fred Matheis, who has been in industrial sales with Thermoid at Trenton headquarters for 20 years, became industrial sales promotion manager.

H. William Overman, manager of Industrial Friction Materials Division, has transferred his headquarters to the Boulevard Building, Detroit.

Jack Wright, who will headquarter at Salt Lake City, has been assigned industrial and oil field sales in Utah, Idaho, Wyoming, Montana and Western Canada.

DAN L. CLARK W. M. AVERILL RUPERT COX

DAN L. CLARK DRILLING COMPANY

Drillers of OIL AND GAS WELLS

POWER AND STEAM RIGS

WILSON BUILDING
CORPUS CHRISTI, TEXAS

Telephones
Local 7746—7747 Long Distance 95

Bill Walmsley

Jay Hembree

Personnel Changes Announced By Thornhill-Craver Company

Thornhill-Craver Company, Houston, manufacturers of Unibolt products, has announced personnel changes. Jay Hembree, who has been salesman for the company in West Texas for two years, has been transferred to Corpus Christi in a similar capacity. Earl Grissom, former sales representative in the Corpus Christi area, was transferred to Oklahoma last month.

Bill Walmsley is a newcomer to the Unibolt sales staff. Prior to joining the company Walmsley was a scout for a major oil company in West Texas, where he will continue to operate as Unibolt sales representative with headquarters at Midland.

R. E. Shafer

James F. Blake

R. E. Shafer Appointed Sales Manager for Wheland Company

R. E. Shafer, has been appointed general sales manager for Wheland Commany. James F. Blake, naval ordnance expert, succeeds Shafer as sales manager of the Oil Field Equipment Division. Joining the rotary equipment manufacturing firm in 1913 as a stenographer, Shafer advanced in succession to the sales staff in the saw mill division, manager of oil field pump sales, purchasing agent for the company and in 1945 was appointed sales manager of the Oil Field Equipment Division.

Blake is an Annapolis graduate and veteran of World War I. Between the two wars he held engineering and executive positions with several California organizations including Union Iron Works, the Stoody Company and Victor Equipment Company.

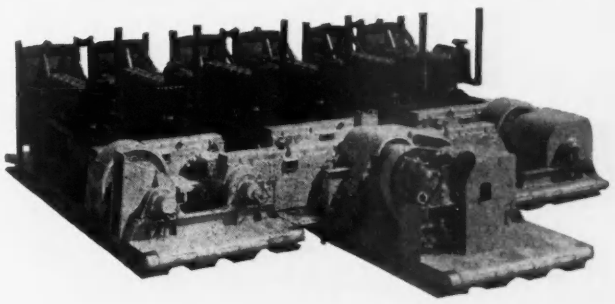
FLEXIBLE POWER

MID-CONTINENT-CUMMINS MULTIPLE ENGINE RIG DRIVE

6

SIX ENGINE RIG DRIVE

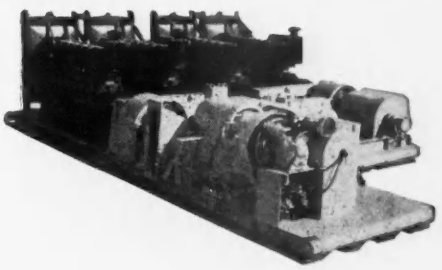
This new multiple engine rig and pump drive group utilizes the combined power of six 240 HP Cummins Model LI-600 Diesel engines (1440 HP) in the most practical and flexible method yet devised.



4

FOUR ENGINE RIG DRIVE

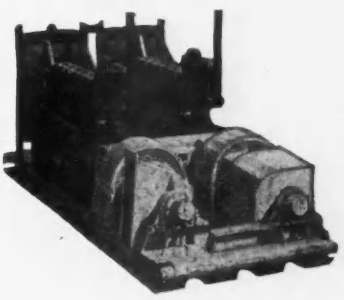
Utilizing two dual engine groups (960HP) by a simple change in position of Drawworks Sprocket forms the four engine power group It provides two pump drives, compressor and Thyrite Generator.



2

TWO ENGINE RIG DRIVE

Conversion to basic two engine power unit (480HP) is accomplished by moving the Drawworks Sprocket and Clutch to No. 3 unit which also provides one pump drive.



. . . . . is the ANSWER to Oil Field POWER PROBLEMS

Three dual engine units are joined together by an efficient system of pivoted swinging compounds (patent pending) and machined spacers. The compounds may be raised to a vertical position which allows the entire group to be converted into three truckloads. All parts are engineered and designed in such a manner that the different power requirement changes are not only simple but positive and accurate. The complete group is built for drilling at depths of 20,000 feet and has a power of 1440 HP.

Designed, assembled and distributed by

MID-CONTINENT Supply Company

General Offices Mid-Continent Bldg. **FORT WORTH, TEXAS**

POWERED BY

CUMMINS Dependable DIESEL

SINCE 1919... PIONEER OF PROFITABLE POWER THROUGH HIGH SPEED DIESELS

EXCLUSIVE DISTRIBUTORS
CUMMINS SALES & SERVICE, INC.
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NEW ORLEANS, LA.—SHREVEPORT, LA.
HOUSTON, TEXAS—OKLAHOMA CITY

WHERE FACTORY TRAINED MECHANICS GIVE EXPERT SERVICE 24 HOURS A DAY

International Harvester Makes Changes in Branch Personnel

W. K. Perkins, manager of sales, International Harvester Motor Truck Division, has announced the following changes in branch personnel:

R. W. Maxwell has been promoted to assistant branch manager of the Buffalo motor truck branch. Maxwell, formerly manager at Binghamton, N. Y., started his career with Harvester at Columbus, Ohio, in 1926. Since that time he has served in various capacities at Cleveland, Pittsburgh, Boston and Elizabeth, N. J.

J. F. Adams, formerly assistant manager of the Charlotte motor truck branch, has been transferred to the Nashville motor truck branch as manager succeeding J. P. Lauffer, who has resigned to enter business as an International truck dealer at Columbia, Tenn. Adams started with the company at Charlotte, Tenn., as a retail salesman in 1936. He was transferred to Charlestown, S. C., in 1940 and returned to Charlotte as assistant manager in 1945, serving in that capacity until his recent promotion.

Economy Pumps Buys Plant

Economy Pumps, Inc., Hamilton, Ohio, has acquired from the War Assets Corporation the wartime addition to its plant, built by the Defense Plant Corporation.

Bottom Water is a costly profit leak

Eagle Lead Wool

***stops* Bottom Water!**

You rule out the risk of oil-wasting bottom water shutdowns when you tamp Eagle Lead Wool in the hole. This finely stranded, non-corrosive metallic wool makes a water-tight plug that seals every crack and crevice. Comes in convenient 50-pound sacks—easy to place in special cartridge-shaped Eagle Wire Containers sized to fit all casings. Order through your jobber today.

These 3 Eagle Bearing Metals meet most requirements

Eagle Dreadnaught—for extreme speed and heavy-duty conditions.

Eagle Outlasta—for medium speed and average-load conditions.

Eagle Durable—for low speed and light-duty conditions.

EAGLE LEAD WOOL

Seals off Bottom Water—keeps 'em flowing!

THE EAGLE-PICHER COMPANY

EAGLE Since EP 1843 PICHER

Cincinnati • East St. Louis • Chicago • Dallas Kansas City

Lloyd J. Ely

John Elwood

Three Factory Managers Appointed In Caterpillar Expansion Program

Appointment of factory managers for the diesel engine, diesel track-type tractor, and earthmoving equipment factories of Caterpillar Tractor Company, Peoria, Ill., has been announced by James R. Munro, general factory manager.

Arthur W. Johnson

Lloyd J. Ely, who has been factory manager, will head Caterpillar's new diesel engine factory, which is currently under construction and is slated for occupancy and partial operation before the end of the year.

John Elwood will have charge of all diesel track-type tractor production, moving up from assistant factory manager.

Arthur W. Johnson, assistant factory manager, becomes factory manager in charge of the manufacture of such earthmoving products in the company's line as diesel wheel-type tractors, diesel motor graders and cable controls, and the final assembly of bulldozers, scrapers and rippers.

Northern Division Sales Agent Appointed by Larkin Packer

H. S. Lindenmuth, Larkin Packer Company, Inc., sales representative in Kansas, has been appointed division manager for the Northern Division, T. E. Alexander, sales manager, announced.

H. S. Lindenmuth

The territory includes the Texas Panhandle, Oklahoma, Kansas, Illinois, Michigan, Kentucky and Indiana. Lindenmuth will continue to make his headquarters in Wichita, Kan.

Lindenmuth joined the Larkin sales organization 13 years ago and has worked the Oklahoma-Kansas area as sales representative during these years.

HOMCO Opens New Service Point

The new Oklahoma City service point of Houston Oil Field Material Company.

The Houston Oil Field Material Company has opened a fishing and cutting tool service point in Oklahoma City, at 2800 Southeast 29th Street. The opening of this service extension was celebrated with an open house featuring a barbecue, which was attended by drilling personnel in the area.

A complete stock of inside and outside cutters, together with the necessary strings of "little inch" drill pipe and washover pipe, is maintained at this location. Also, spears, overshots, rotary shoes, and all the necessary tools for emergency operations involved in drilling, are located at this point for industry use.

It is also planned to completely equip this store with the directional drilling tools and operators necessary for this type of service in Oklahoma.

Raymond G. Alford is the store manager. Russell Yost, Bob Acuff and Grover Pool are operators stationed in the area. Joe Zachary and W. W. Liddell are store men.

Allis-Chalmers Completes 100th Year of Its Existence

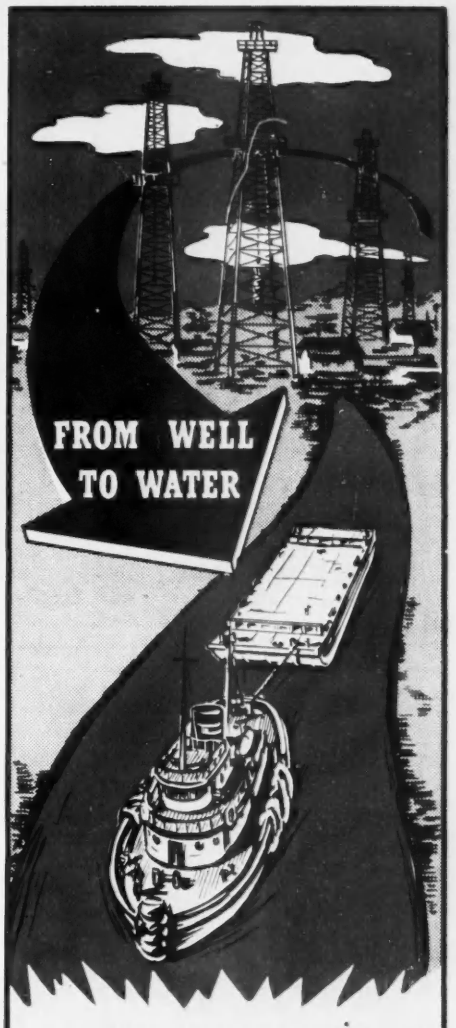
Coinciding with the greatest period of U. S. industrial development, Allis-Chalmers this year completes a 100-year record of engineering and manufacturing.

Started in 1847 as a finisher of French burr mill stones to help equip the mills which were soon to make Milwaukee the upper Great Lakes' leading wheat and flour market, Allis-Chalmers represents an organization formed from 16 separate firms which today is supplying more than 1600 different products to industries all over the world.

This giant producer of power generation, power distribution and power utilization equipment was conceived by Edward P. Allis, a native of Cazenovia, N. Y., who with two other men, acquired the original firm in 1861.

National Geophysical Staff Meets

Thirty-two members of the technical staff of National Geophysical Company met December 5 at Dallas with the executive staff to interchange ideas on operating and interpretational techniques. The following technical papers were presented: "Theodolite Surveying," K. H. Waters; "Azimuth Determination," W. A. Reeves; "Shoran Surveying," J. Appendino; "Marine Operations," accompanied by a color movie, by W. J. Harkey; "Marine Operating Problems," R. A. Boulware; "Winter Seismic Operations," E. L. Campbell; "Wave Front Method of Plotting Reflection Cross Sections," A. G. Morton; "General Aspects of Refraction Shooting," L. Shock.



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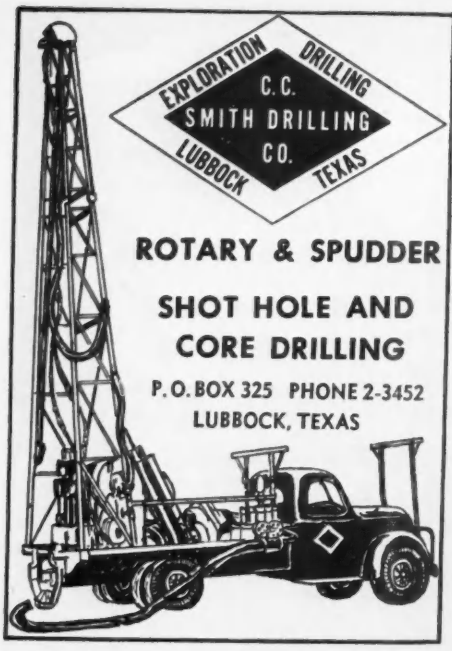

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ECOLITE-92BM

With Locking Device and Seals

TWICE APPROVED for DOUBLE SAFETY

Approved by U. S. Bureau of Mines and Underwriters' Laboratories

—for use in atmospheres containing Methane or natural gas, gasoline or petroleum vapors.

This double-safety lantern has a tamper-proof reflector and cover with locking device and seals. Throws 1500 foot beam. Instantly ejects broken bulbs from battery circuit. Large handle. 360° pivoting feature gives direct illumination where needed and leaves both hands free for work.

Now at Supply Stores

ECONOMY ELECTRIC LANTERN CO.

Sturgeon Bay, Wisconsin

MANUFACTURERS' and SUPPLIERS' NOTES

138 in National Supply's 25-Year Club

President A. E. Walker, chairman of the board and president of The National Supply Company, Pittsburgh (left), congratulates Michael J. Smith, sizing mill operator at the Ambridge, Penn., plant of the Spang-Chalfant division of the company, after awarding him a gold pin set with five diamonds on completing 25 years of service. Smith was one of 22 employes of the plant who received pins and membership in the plant's Twenty-Five Year Club. The club now has 138 members.

F. C. Awtry

W. A. Pitts

Wheland Company Announces Two Additions to Sales Personnel

The Wheland Company of Chattanooga, manufacturers of rotary drilling equipment, announced the addition of W. A. (Bill) Pitts and Francis C. Awtry to their sales staff.

Pitts spent a number of years with the Regan Forge and Engineering Company, Chain Belt Company, and Lucey Products Company, covering the Mid-Continent and Gulf Coast areas. Awtry, a native of Waxahachie, Texas, entered the oil business at Electra, Texas, as a roughneck with Globe Drilling Company and was store manager in charge of rotary equipment sales for The National Supply Company at Electra.

Esch Incorporates

Frank M. Esch Company, 108 Portwood, Houston, has incorporated under the name of Esch-Condit, Inc. Officers are Frank M. Esch, president and treasurer; Paul A. Condit, vice president; Robert B. Miller, secretary; and Jim W. Muster, assistant secretary and treasurer.

R. F. Farmer Appointed Assistant Sales Manager for Cameron Iron

Cameron Iron Works, Houston, has announced the appointment of R. F. (Bob) Farmer as assistant sales manager. Farmer has been in the oil tool supply and manufacturing industry of the Gulf Coast and Mid-Continent for the past 10 years. He joined Cameron's sales department in 1942, working in the Houston territory, and later was transferred to Corpus Christi. In 1944 he was sent to Tulsa as Mid-Continent Division manager. From that position he was promoted to assistant sales manager on September 1, returning to the company's Houston headquarters.

R. F. (Bob) Farmer

R. W. Gustine, formerly Cameron sales representative at Shreveport, has been transferred to Tulsa to succeed Farmer. He will make his headquarters in the Thompson Building.

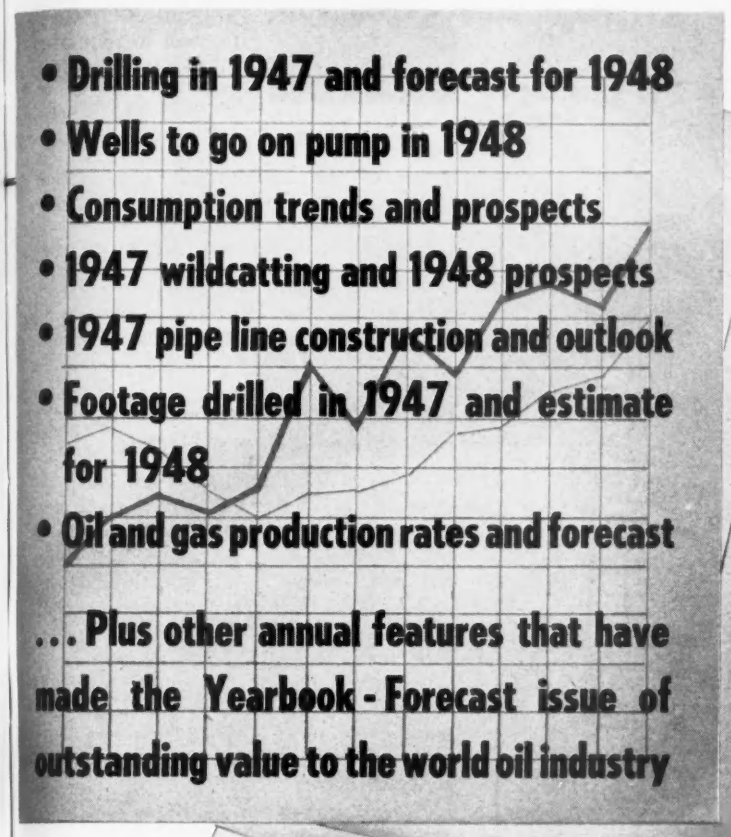
Caterpillar Tractor Appoints Engine Sales Consultant

Appointment of Jack H. Gill as engine sales consultant for Caterpillar Tractor Company was announced by H. H. Howard, general sales manager.

Gill will advise, coordinate, and plan the development of engine sales with sales managers at the main offices in Peoria, Ill.

THE 1948 YEARBOOK-FORECAST

Petroleum facts and forecasts FOR YOU!



- **Drilling in 1947 and forecast for 1948**
- **Wells to go on pump in 1948**
- **Consumption trends and prospects**
- **1947 wildcatting and 1948 prospects**
- **1947 pipe line construction and outlook**
- **Footage drilled in 1947 and estimate for 1948**
- **Oil and gas production rates and forecast**

... Plus other annual features that have made the Yearbook-Forecast issue of outstanding value to the world oil industry

SOME TANGIBLE FIRSTS

First to get cooperation of oil companies in translating their budgets into forecasts.

First to establish annual forecasts of any kind.

First to launch a composite summary sheet for the industry.

First publication to estimate crude reserves.

First to compile data on footage drilled.

First to publish detailed history of important producing districts.

First to employ full-time editor on petroleum economics.

First to develop annual review of all exploratory operations of previous year.

First in completeness of data published yearly.

Undisputed leader in recording the oil industry's statistics since 1918

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Check branch of industry

- ☐ Drilling Contractor
- ☐ Producing Company
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- ☐ Individual Producer
- ☐ Manufacturing
- ☐ Supply

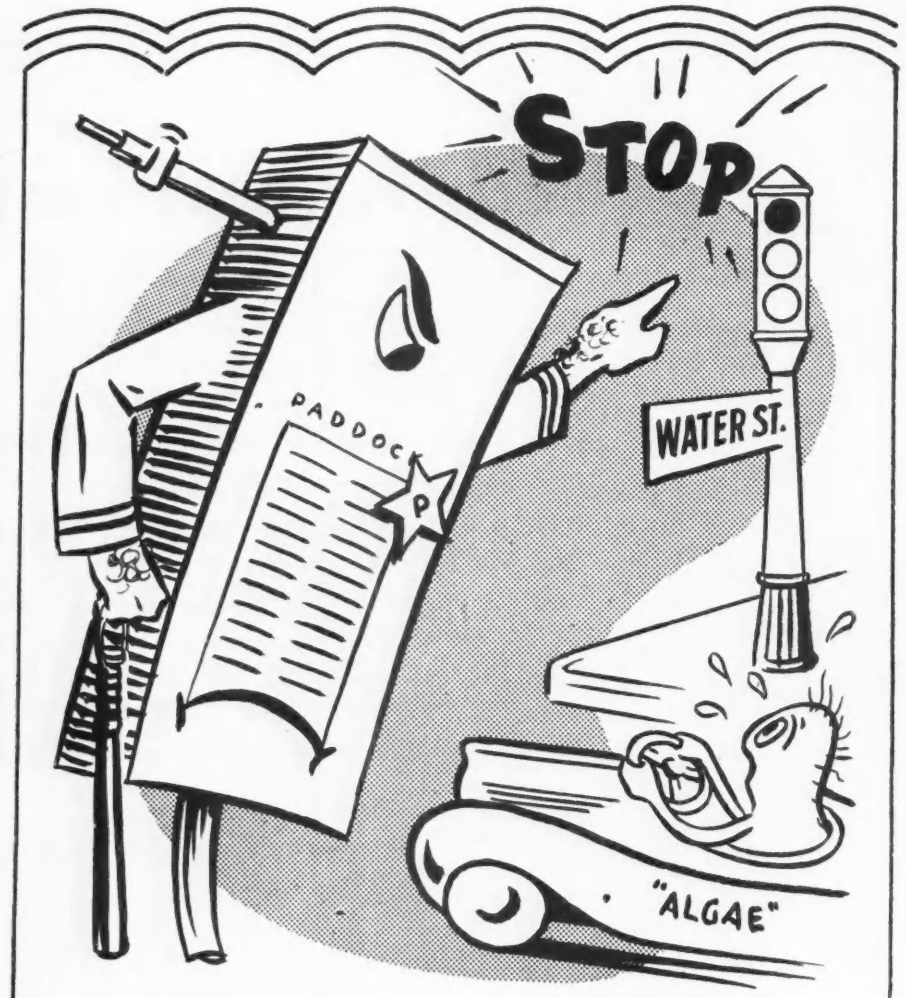
ANDY COUPON NOW

New Factory Being Constructed In Caterpillar Expansion Program

Construction of a factory to house facilities for the manufacture of diesel wheel-type tractors and diesel motor graders and for the final assembly of scrapers, wagons and rippers has been initiated by Caterpillar Tractor Company, Peoria 8, Ill.

The earthmoving equipment factory is being constructed in an area near the new diesel engine factory, currently nearing completion and scheduled for partial operation before the end of the year.

This latest phase of the Company's progressively executed program of expansion is another step towards increased production without interruption of existing manufacturing processes. It supplements the construction of the new diesel engine factory, jig and fixture storage building, additions to the parts and the factory administration buildings, expanded heat treat facilities and the company's heating plant and a new Cold Test building to supplement the facilities of the Research Department.



The PADDOCK High-Capacity CHLORINATOR stops that algae—keeps water systems and cooling towers from getting fouled up with destructive bacteria. The Paddock Chlorinator can handle up to 1,000 pounds per 24 hours within 4% positive control. No float boxes or float valves to need replacement or repair. All parts of silver, plastic or glass. Effective and economical. Stop water problems with a Paddock Chlorinator.

Also write and ask us about SURECLOR, the new portable water-chlorinating unit for temporary camps.

Paddock Engineering Co. of Texas

900 South Ervay Dallas 1, Texas

Vice President for Production Named by R. G. LeTourneau Firm

Elmer E. Isgren, pioneer member of R. G. LeTourneau, Inc., has been appointed vice president in charge of production. He will be responsible for all manufacturing operations at the LeTourneau plants in Peoria, Illinois; Toccoa, Georgia; Vicksburg, Miss.; and Longview, Texas, and will headquarter at Peoria, Ill., where the general offices of the company are located.

Elmer E. Isgren

Isgren also is a director of the LeTourneau Corporation and for the past year has been manager of the Longview plant.

Isgren joined LeTourneau at its original Stockton, Calif., plant in 1930. Early in 1935 he helped pioneer the company's midwest plant at Peoria, Ill., as welding superintendent, plant superintendent, then plant manager.

New York Executives Named by International General Electric

Clement R. Tunell was named manager of the New York Divisions, and Clifford F. Storms, assistant manager of the New York Divisions, for International General Electric Company, Inc.

Tunell, former assistant manager of the New York Divisions, completed his G-E test course in 1928 and joined the Apparatus Division, Schenectady, as commercial engineer. In 1931 he was transferred to the New York Divisions, and in 1934 he was made section head of those divisions.

Storms joined the New York office of the I.G.E. Company in 1944 as a sales engineer. In may, 1947, he was made manager, Utilities, Foreign Government Agencies, Consulting Engineers & Contractors Division, a position he held until his recent appointment.

W. B. Whenthoff Is Tube Turns Marketing Director at Houston

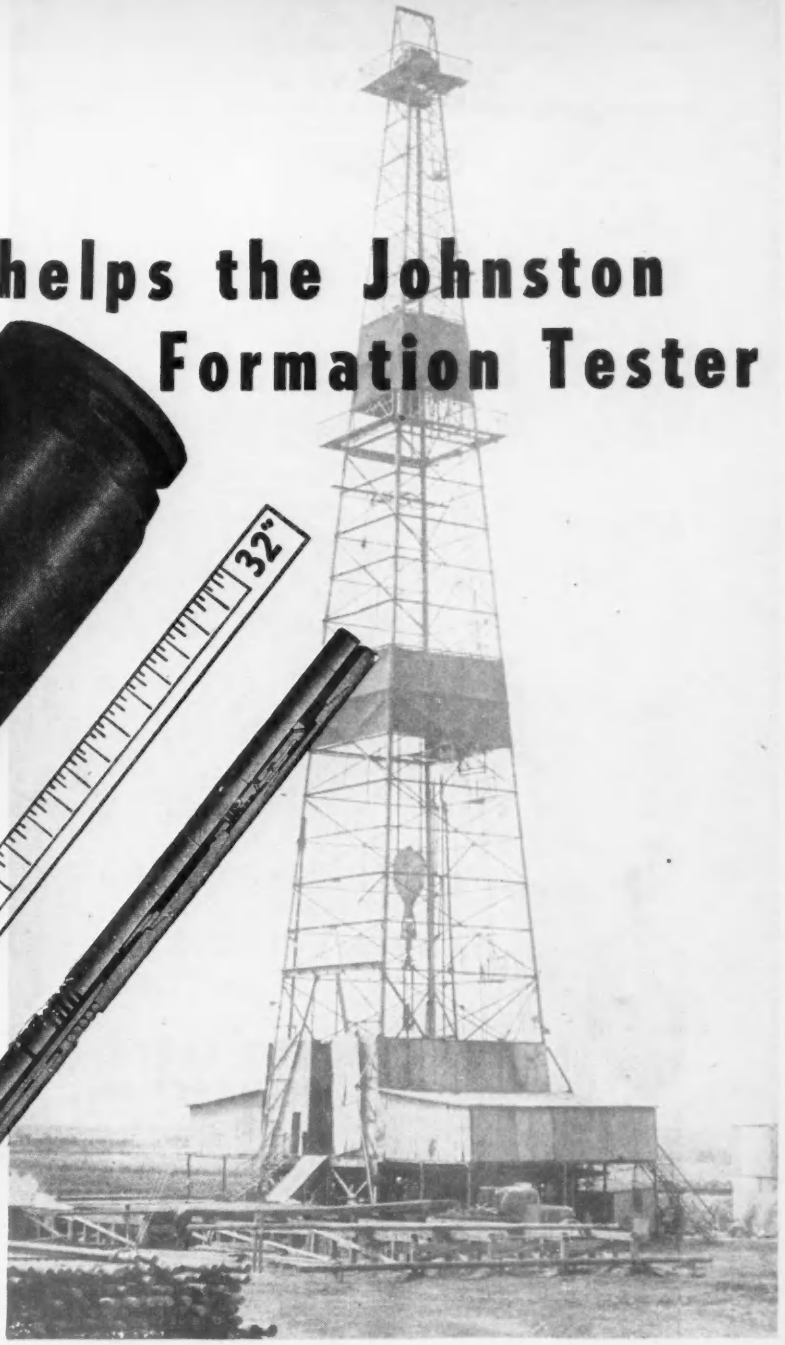
W. B. Whenthoff has returned to Houston and again is in charge of marketing the products of Tube Turns, Inc., in that area.

A native of Globe, Ariz., Whenthoff's entire career has been devoted to the sale of industrial supplies and equipment in the West, Southwest, and Mexico.

He became associated with Tube Turns, Inc., in 1937, when he opened the firm's Tulsa office. He established Tube Turns' Houston office in 1941.

W. B. Whenthoff

Murray Rubber helps the Johnston Formation Tester



Deliver the Facts!

The Johnston Formation Tester has built a world-wide reputation for "delivering the facts" about formations penetrated by the drill.

The successful operation of this unique tool, which has saved countless strings of casing that would otherwise have been set for fruitless production tests, depends on a 32" long rubber packing element for packing off in open hole to isolate the testing zone.

For many years, the Johnston Oil Field Service Corporation has been a satisfied Murray customer, along with scores of other prominent oil field equipment producers.

Long and specialized experience in this field enables Murray to get to the bottom of your mechanical rubber problems with a minimum of lost motion and experimental expense. Our engineers are capable oil tool designers who will gladly consult with you in perfecting your rubber parts.

A completely equipped and ably staffed tool and mold division, devoted entirely to the production of customer's molds, dies, metal inserts, etc., together with the most modern facilities for both compression and injection molding, are at your disposal.

MURRAY RUBBER COMPANY

HOUSTON, TEXAS

R. C. Glover

C. J. Berlin

H. F. Harper

E. F. Hannon

A. K. Kline

G. E. Turner

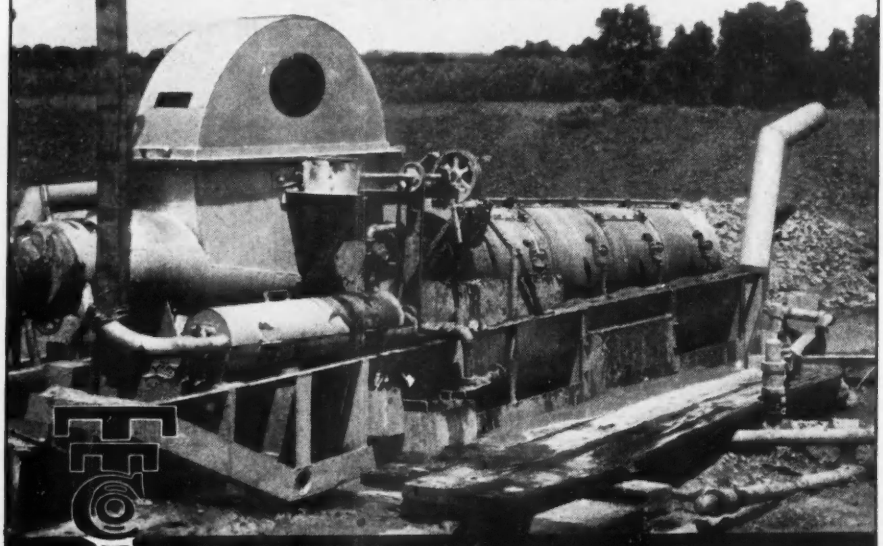
Thompson

SHALE SEPARATOR AND SAMPLE MACHINE

REMOVES ABRASIVES

PROVIDES ACCURATE SAMPLES OF CUTTINGS

A MODEL FOR EVERY CAPACITY REQUIREMENT



Far less depreciation on expensive drilling equipment . . . no power failures or expense . . . accurate samples of cuttings with fast, simple control. Thompson gives you the best of everything to clean and recondition mud. Thompson Model "DWF" easily handles flow of mud from the largest mud pump you can buy. Field-tested *sample machine* is standard equipment on every model . . . pays for the entire separator in a short time. Your dealer is ready to fill your order now.

THOMPSON TOOL CO.

IOWA PARK, TEXAS

Appointment of District Managers Announced by Baker Oil Tools

New district managers with service records of seven to 15 years have been named by Baker Oil Tools, Inc.

R. D. McBrian

The new managers are: C. J. Berlin, Dallas district with headquarters at Dallas; E. F. Hannon, Texas Gulf Coast, Houston; H. F. Harper, Southwest Texas, Corpus Christi; A. K. Kline, Olney district, Olney, Ill.; G. E. Turner, Louisiana Gulf Coast, Harvey, La.

R. C. Glover will continue as district manager at Tulsa, and R. D. McBrian will remain as district manager in West Texas with headquarters at Odessa.

Vice President Appointed for Weatherford Spring of Venezuela

J. E. (Jimmy) Berry, former drilling superintendent for Shell Oil Company, has become vice president of Weatherford Spring Company, of Venezuela, C. A., distributors of oil well cementing tools operating internationally. Berry has been connected with the oil industry since 1933, having worked in Texas, Louisiana and for the past ten years in Western Venezuela as driller, tool pusher and drilling superintendent.

J. E. Berry

Assistant to President Miller Appointed by Oil Base Firm

Oil Base, Inc., Compton, Calif., announced the appointment of Jack Podlech as assistant to the president and counsel. Podlech, a member of the California Bar Association, was previously with Richfield Oil Company's Land and Lease Department, and with the Trust Division of the Citizen's National Bank, Los Angeles.

Podlech will head up the newly formed Legal Department at Oil Base, Inc., under the supervision of George Miller, president.

For a Perfect Score

. . . Rifle accuracy in building oil well pumps . . . accurate sights, accurate machining, accurate gauges.

PUMPS THAT HOLD TRUE ON TARGET

PRECISION FINISH IS THE TARGET IN THE MANUFACTURE OF PACIFIC OIL WELL PLUNGER PUMPS.

Plungers and liners are manufactured from metals and alloys that best meet the varying conditions in each field. But while materials vary to meet specific pumping conditions, there are no variations in *Pacific's advanced standards of accuracy.*

Plungers are machined from seamless steel tubing which has proved most durable by years of testing. Available with or without hard chromium plate. Plating makes them highly resistant to corrosion and abrasion. Diameters are finish ground to a tolerance of within .0005" of specified diameter.

Sectional liners are made of *Moloy* of X or XX hardness, XXX hard graphitic steel, or S-XXX stainless steel—precision-honed to a mirror finish, then tested for "rifle bore" accuracy.

Precision machines, especially designed, and gauges of extreme accuracy insure *Pacific finish* that holds to the target of perfection right through each manufacturing phase.

On your lease, in your wells, Pacific Precision-Built Pumps insure a *perfect score.* Try them!

PACIFIC *Precision Built* **PUMPS**

Pacific Liners are accurately inspected and checked with special gauges to insure uniform and accurate A.P.I. tolerances throughout *the entire length of liner.*

PACIFIC PUMPS, INC.
HUNTINGTON PARK, CALIFORNIA

One of the Dresser Industries

NEW Books

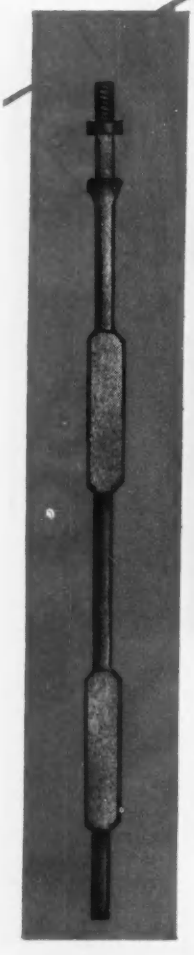
Gas Facts

Comprehensive factual data on the gas utility industry are assembled in a 176-page volume, "Gas Facts," the first in a new series of annual statistical yearbooks which will be published by the American Gas Association.

The book's nine sections and 150 tables give accurate, up-to-date information on gaseous energy reserves; production, transmission, distribution, sales, and utilization of manufactured, natural, mixed, and liquefied petroleum gases; and price, labor, and financial data on the industry. Much of the material is original, but the book also contains a large amount of information from other sources which has a direct bearing on the gas utility industry.

Copies are available at $1. Orders should be addressed to Bureau of Statistics, American Gas Association, 420 Lexington Avenue, New York 17.

Look AT THE SAVINGS YOU MAKE with HUBER PARAFFIN SCRAPERS



	WELL No. 1		WELL No. 2	
	Year Before Install.	Year After Install.	Year Before Install.	Year After Install.
Paraffin Expense	$1347.00	-0-	$ 767	-0-
Bbls. Oil Prod.	9859	9046	9978	8502
Paraffin Cost per Bbl.	$ .137	-0-	$ .077	-0-
Expense Reduction	$1347		$ 767	
First Yr's Operation Installation Cost	401		401	
NET SAVING	$ 946		$ 366	

ROTATING HEAD

This patented head automatically rotates the rod string a fraction of a turn on each reciprocation, so that the scrapers, which clear the tubing by a fraction of an inch, wipe the wall free of paraffin.

Here are the savings a major company made in one year with Huber Scrapers in two of their pumping wells. Well No. 1 saved more than twice the cost of the scrapers. Well No. 2 saved about 90% of their cost. Huber scrapers completely eliminated all paraffin removal expense.

It will pay you to install Huber Scrapers in your pumping wells where paraffin is accumulating. Install them now and end this costly paraffin trouble.

ORDER FROM YOUR SUPPLY STORE

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Drilling, Production Practice

The 1946 edition of "Drilling and Production Practice" has just been published. This edition includes those articles selected by the American Petroleum Institute's Central Committee on Drilling and Production Practice from papers presented at the annual meeting as well as district and chapter meetings of the Division during 1946.

The papers are grouped under the headings of drilling practice, production practice, materials, and miscellaneous. In addition to the selected articles, this volume contains a bibliography (with abstracts of papers that are not reproduced in full) of all papers presented at district meetings in 1946. A supplement to the bibliography on secondary recovery has been brought up-to-date by the inclusion of references for the year 1946.

Published by American Petroleum Institute, 50 West 50th Street, New York 20, N. Y.

Colorado Guide Book

A field conference in central Colorado, sponsored by the Rocky Mountain Association of Geologists, was held in the summer of 1947. The guidebook for the conference includes a detailed road log from Denver to Glenwood Springs over U. S. Highways 40 and 6; Glenwood Springs to Leadville over Independence Pass; and Leadville to Cripple Creek, through Florissant.

The guidebook also contains ten papers on the geology of the central Colorado region, illustrated by maps and geologic cross sections. A selected bibliography lists about 80 papers on the region. Copies are available at $5 each. Address Rocky Mountain Association of Geologists, 230 New Customhouse, Denver 2.

Geophysical Abstracts

The U. S. Geological Survey has resumed publication of the Geophysical Abstracts after a four-year interval, during which they were issued by the U. S. Bureau of Mines.

The Geophysical Abstracts are published quarterly as an aid to those engaged in geophysical research and exploration. The bulletin covers world literature on geophysics contained in periodicals, books, and patents. It deals with exploration by gravitational, magnetic, seismic, electrical, radioactive, geothermal, and geochemical methods and with underlying geophysical theory and related subjects.

Copies may be purchased singly or by annual subscription from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. For subscription, the Superintendent of Documents will accept a deposit of $5 in payment for subsequent issues. When this fund is near depletion the subscriber will be notified. The deposit also may be used to cover purchase of any other publication from the superintendent of documents.